

September 1993/\$3.00

# Mobile Radio Technology

TM

The journal of mobile communications technology

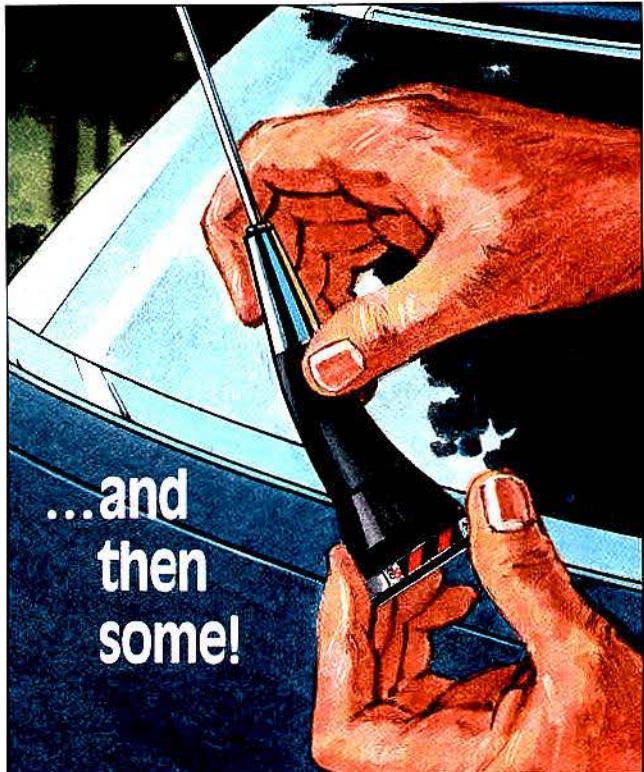
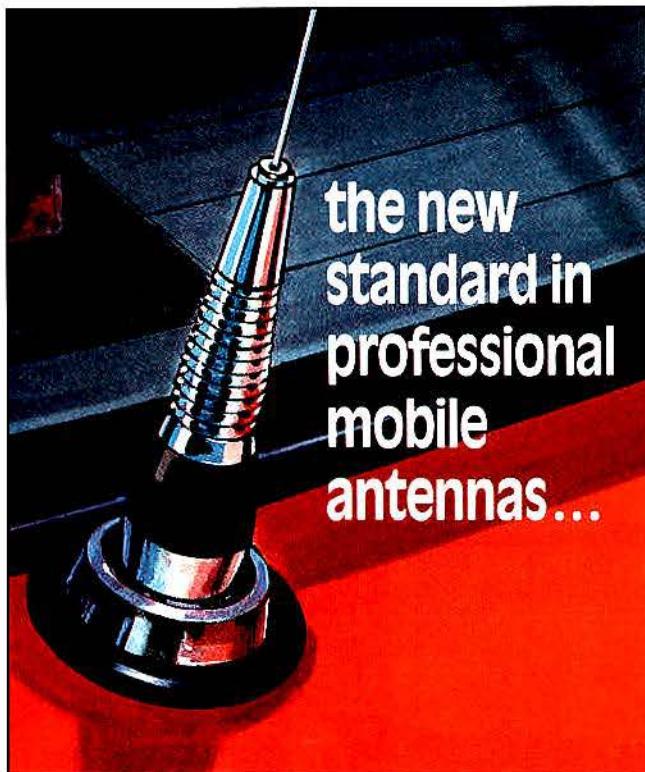


Site safety, p. 10

Behind the FCC label  
Narrowband technology  
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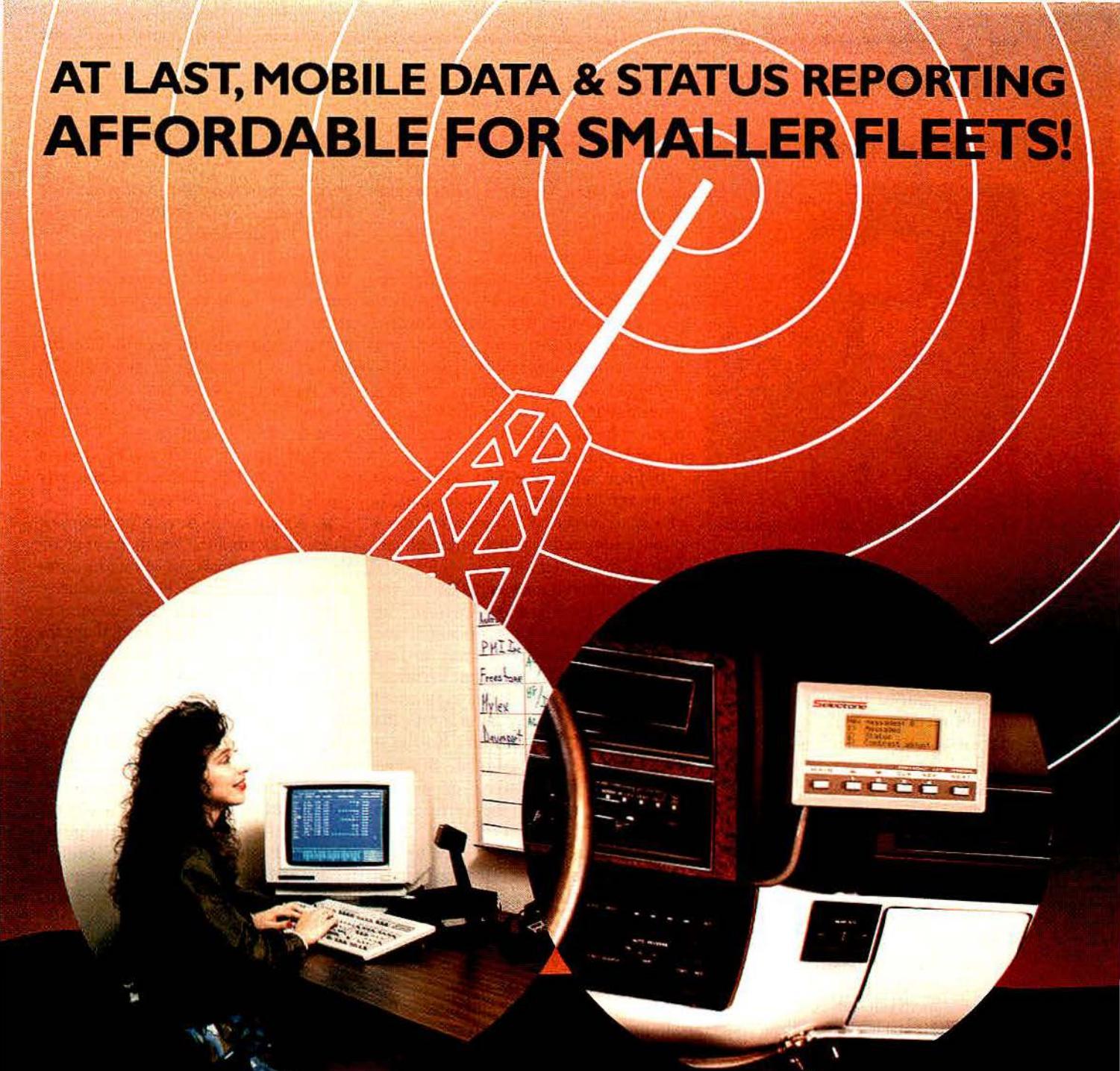
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**On the cover:** Employees of Broadcast Communications, New Glarus, WI, use safety equipment and procedures while working on a steel tower. See Donald E. Koehler's article on page 10.

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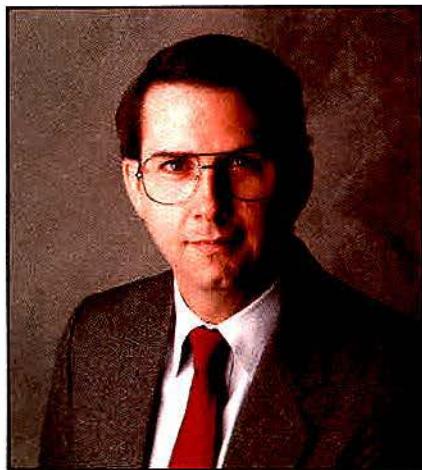
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## Technician association elects volunteer leaders



During its May 1993 meeting, the Association of Communications Technicians' (ACT) volunteer leadership council expanded the council from five to eight members. ACT is a membership section of the National Association of Business and Educational Radio (NABER), Alexandria, VA.

Three council members continue in unexpired terms: Steve Ambo of Dechant Electronics, Wood River, IL; Gary Matheson of ITT Technical Institute, Tampa, FL; and Forrest Collier of Paging USA, Indianapolis.

Re-elected to two-year terms are Thomas Green Sr. of Ranken Technical College, St. Louis; and Jack Ford of Pagecom Systems, Somerset, NJ. Green, the current council chairman, was re-elected chairman for two years.

New council members elected to two-year terms are James C. Folmer of Syntonic Technology, Lanham, MD; and Wayne F. Wantland of the Yakima, WA, city fire department. Ian Wright of Dominion Communications Systems, Colonial Heights, VA, a former council chairman for four years, was elected to return to the council for a one-year term.

ACT members supplied the council with nominations. A two-member committee of council members evaluated the nominations and, following its usual procedure, forwarded to the council for a vote the same number of

names as there were open seats on the council.

### New council members

► Folmer is a senior lead technician with Syntonic. His work with the company has included field technical work, service and project management, and engineering responsibilities, depending upon varying customer contract requirements. Including his military service, he has 23 years of experience in radio communications.

Folmer said he joined ACT three years ago to support technician certification, to subscribe to the association's publications and to add another dimension to his credentials.

"Syntonic requires certification for certain job levels and expertise," he said. "I see value to certification, and I joined the council in part to find out what others think about certification requirements. I am concerned that certification may be going to the wayside, and I would like to see it go the other way. Maybe, through ACT and NABER, there is enough influence to increase the certification requirements."

Folmer said he would like to see ACT increase the information it provides for field technicians, whether it be job-related, career-related or helpful in day-to-day tasks.

► Wantland began working for the city of Yakima 11 years ago as an electronics technician, and now is the communication and electronics supervisor in charge of Yakima's C&E service center and the consolidated fire dispatch center.

He is the Associated Public-Safety Communications Officers' (APCO) automated frequency coordination frequency adviser for Eastern Washington, and he is a member of the Region 43 National Public Safety Plan Advisory Committee. He is certified by APCO and NABER as a technician.

Referring to what some see as a diminishing role for technicians in servicing modern two-way radios, Wantland said: "I would like to see the council address the issue of the 'last technician' philosophy that seems to

pervade the industry. Although service centers may have less component-level repair responsibility, the systems and options in the world are so complex that the users need a service center to help them with the decisions facing them."

Wantland said he would like the council to become or to stay active in the regulatory issues that face the industry. "We, as technicians, should be able to offer insight to the FCC and Capitol Hill on these issues from a perspective they will not necessarily get from others," he said.

► Wright, who is vice president of sales at Dominion, began serving on the NABER board of directors after serving the limit of two consecutive two-year terms on the ACT council as its chairman, beginning when the technician association was formed.

Wright said he would like to help ACT's membership grow. In addition, he suggested that ACT publish a single-page hot-issues newsletter. "A technician would skim over something lengthy. But a newsletter that takes five minutes to read and that tells where the industry is going would be helpful." One immediate purpose of such a newsletter, he said, might be to quash some of the inaccurate rumors circulating about spectrum rearming.

We support ACT, and we hope the continuing and new council members will be successful in achieving their goals.

We encourage communications technicians to consider joining the association. Information about ACT is available by calling 800-759-0300; ask for "technician services."

—Don Bishop

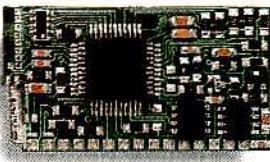
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21-23—**International Wireless Communications Expo/Fall**, Philadelphia Convention Center, Philadelphia. Contact: 303-220-0600.  
**28-Oct. 1—Mobile Communications Marketplace**, New Orleans Convention Center, New Orleans. Contact: Telocator, 800-326-8638.

**October**

**18-19—SMR Management Conference**, sponsored by American Mobile Telecommunications Association, Hyatt Regency Tech Center, Denver. Contact: 202-331-7773.  
**21-23—Government Affairs Summit/Fall Meeting**, sponsored by the National Association of Business and Educational Radio (NABER), Ritz-Carlton Hotel, McLean, VA. Contact: 800-759-0300.

**November**

**2-4—WirelessWorld Conference & Exhibition**, sponsored by *Cellular Business* magazine, Buena Vista Palace, Lake Buena Vista, FL. Contact: Chris Lotesto, 800-458-0479.  
**4-6—Industrial Telecommunications Association**, La Quinta Hotel, La Quinta, CA. Contact: Barbara J. Levermann, 703-528-5115.  
**11-14—Communications Marketing Conference**, Holiday Inn Riverwalk, San Antonio. Contact: Gene Johnson, Vega Signaling, 818-442-0782.  
**19—Radio Club of America**, Communications Symposium and Annual Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

**1994****February**

**7-8—AMTEX**, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Marriott on International Drive, Orlando, FL. Contact: 202-331-7773.

**March**

**2-4—Cellular Telecommunications Industry Association Winter Meeting and Exposition**, San Diego. Contact: 202-785-0081.

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The journal of mobile communications technology

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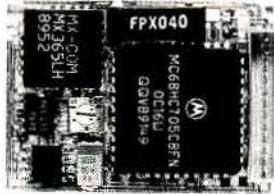
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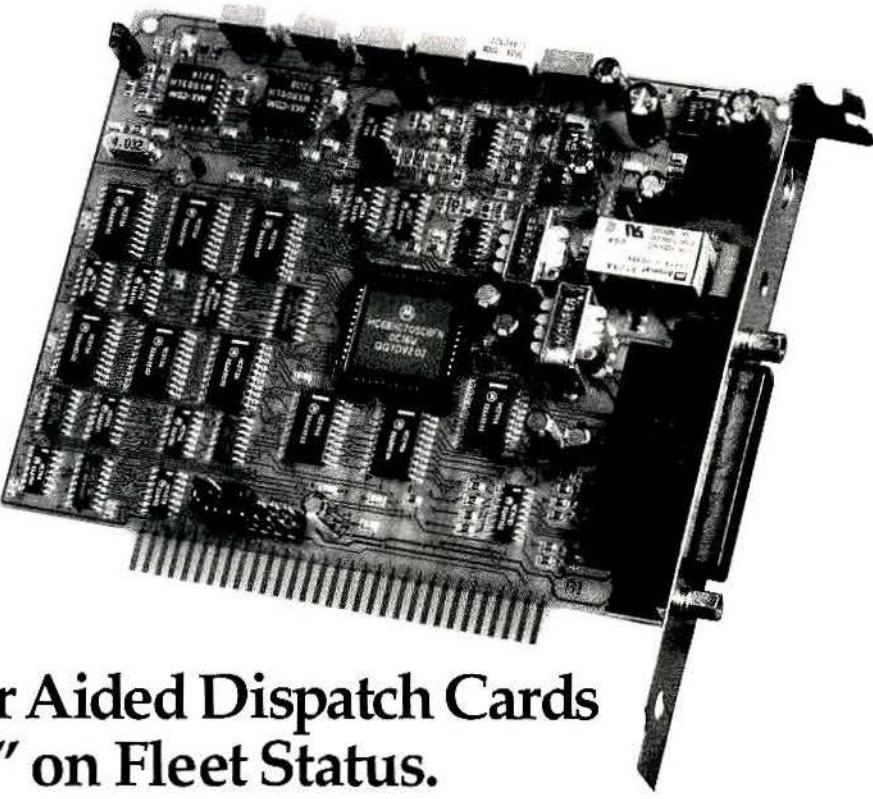
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Circle (7) on Fast Fact Card

## Transmitter noise

By Harold Kinley, CET

Transmitter sideband noise is a problem that must be taken into account when operating a receiver and transmitter in close proximity and at close frequency spacings.

The best way to describe transmitter noise solutions is to look at examples. The following examples and illustrations should help you to understand how to calculate the isolation (signal attenuation) required to keep transmitter noise from degrading the radio signal reception at nearby receivers.

In Figure 1A below, the transmitter operates at 159.345MHz and the receiver at 159.120MHz. Both antennas are 6dB-gain omni-directional units composed of four stacked folded dipoles.

The transmitter power is 100W (50dBm), and the receiver sensitivity

is  $0.35\mu V$  ( $-116\text{dBm}$ ) at 12dB SINAD. To prevent the transmitter noise from interfering with signal reception at 159.120MHz, noise coming from the transmitter on 159.120MHz must be attenuated to a level below the receiver sensitivity or below  $-116\text{dBm}$ .

Usually, to minimize received signal degradation, transmitter noise is attenuated at least 10dB below the receiver's sensitivity. In this case, the transmitter noise would have to be suppressed to a level of  $-126\text{dBm}$ .

How much attenuation or isolation is required?

First, you must know the level of the transmitter noise at the particular frequency of interest.

The best way to determine this is to refer to the manufacturer's data sheet or graph of transmitter noise level vs. frequency. Manufacturers should be able to supply this information on request.

If you do not have the data sheet or graph, the situation is not hopeless. FCC rules and regulations establish minimum standards that all transmitters must meet.

According to FCC requirements, transmitter noise at 159.120MHz (from

the 159.345MHz transmitter) must be down at least  $43 + 10\log(P)$  decibels below the carrier level (dBc) or 80dB, whichever is the lesser attenuation.

Transmitter carrier power is 100W. Substituting into the formula:

Attenuation (dB)

$$= 43 + 10\log(100)$$

$$= 43 + 10(2)$$

$$= 43 + 20$$

$$= 63\text{dB}$$

Because 63dB is less attenuation than 80dB, 63dB is the attenuation figure to be used, which means that the transmitter noise at 159.120MHz should be down 63dB from the carrier power level.

Because the carrier power level is 100W or 50dBm, the transmitter noise level must be no more than  $50\text{dBm} - 63\text{dBm} = -13\text{dBm}$  at the transmitter output.

Loss in the transmission line and any filters, duplexer, isolator and other passive equipment must be taken into account. Let's say that no filters or duplexers are used at first, and that the line loss is 2dB.

Next, the isolation or signal attenuation between the transmitting and receiving antennas must be determined.

Figure 2 on page 56 can be used to approximate the isolation between the antennas. Figure 2A is for vertically separated antennas. Figure 2B is for horizontally separated antennas.

For a horizontal separation of 200 feet, the graph (150MHz) shows attenuation to be approximately 50dB. Remember, though, that for horizontal separations, the sum of the gains of the two antennas must be deducted from the isolation figure on the graph.

Because both antennas have 6dB gain, 12dB must be deducted from the figure on the graph:  $50\text{dB} - 12\text{dB} = 38\text{dB}$ . Thus, the isolation between the antennas in Figure 1A is 38dB.

On the receiver side, again, the line

(continued on page 56)

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

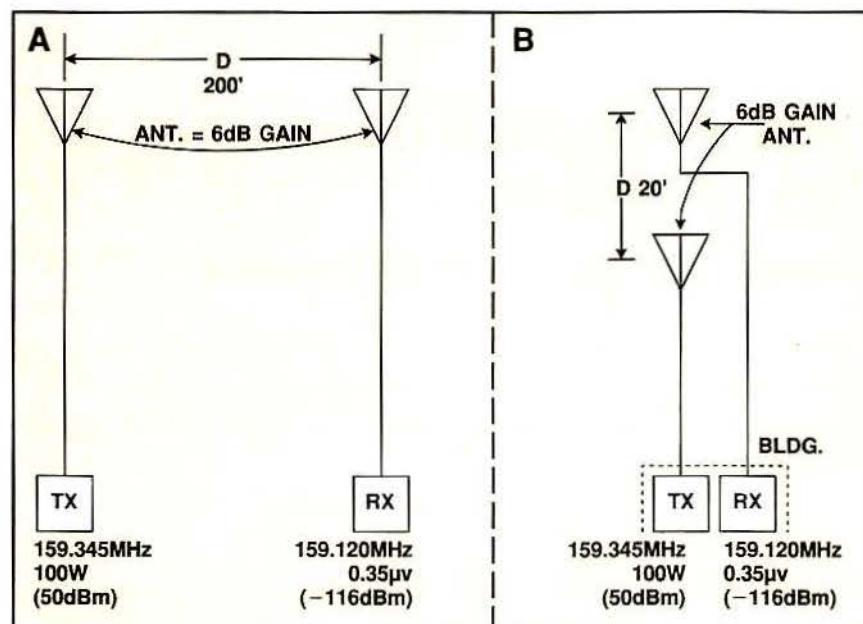


Figure 1. At (A), the antennas are separated horizontally (equipment in different buildings). At (B), the antennas are separated vertically with equipment in same building and antennas located on same tower. In this example, the 20 feet of vertical spacing between the antennas provides much better isolation than the 200 feet of horizontal spacing.

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# Site safety: Planning for success

*Identify safety hazards, write safety rules and train workers how to eliminate or mitigate the risks posed by the safety hazards. A good safety plan protects workers and equipment, and reduces potential liabilities.*

By Donald E. Koehler

Site safety begins with a comprehensive written safety plan. To write a successful plan, include at least these four parts:

► **Involvement and commitment**—Develop a policy statement that outlines the minimum responsibilities of workers, supervisors and managers.

Establish priorities and, when appropriate, deadlines. Assign accountability for managers and workers.

In addition, the statement can include goals for safety and health.

► **Hazard identification and controls**—Describe site hazards that are or may be present.

Provide for an initial hazard survey and intervals for follow-up inspections or surveys. Outline a method or procedure for workers to report hazards.

Describe how to keep records of identified hazards, when they were reported and the corrective measures taken to eliminate or mitigate them. Some states require such record-keeping and have further requirements. Check with your state's occupational safety and health service.

As part of the assessment and control process, the plan should define procedures for accident or mishap reporting and investigation. The procedures must identify accident causes and recommend corrective actions.

Koehler is a technical writer, technical resource researcher, and computer, communications and database specialist for Harte Management Consultants, Anchorage, AK.

The procedures should outline actions to prevent similar accidents.

Specify a monitoring procedure to track work-related illness and injuries. Such monitoring helps to involve managers in the safety program.

Identify how personal protective equipment (PPE) and specific produc-

when new or upgraded systems are installed.

Scrutinize the equipment design, installation, engineering and planned maintenance for known or possible hazards to workers.

Safety rules should cover general principles, such as no horseplay on the job site, and specific operations.

Operation-specific safety rules may cover battery bank testing, generator set refueling and how to maintain the grounding system while the site is powered and operating. Post these rules in a prominent location at the shop and on the site as a reminder. Include in the orientation procedure for new employees a review of the rules, and obtain from new employees a signed statement confirming that they have read the rules and that they understand them.

Standard work practices or procedures are important when several workers perform maintenance at an equipment site.

Develop the procedures with worker participation. Ask a safety professional who is familiar with electronic maintenance practices to review them.

As with any maintenance effort, these rules and procedures must be part of the organization's training program. Enforcing the rules with a fair and understandable disciplinary policy is part of a management process to ensure standard work rules and procedures protect all workers.

► **Occupational safety health and training**—All new workers should be trained regarding site-specific hazards known or presumed to exist.

## Safety plan elements

- **Expressed management involvement and commitment.**
- **Hazard identification and controls.**
- **Planning and setting safety rules and standardized work rules.**
- **Occupational safety and health training.**

tion equipment should be used.

For example, when to use gloves and when/how to shore a trench can be included directly in the plan. Alternatively, they can be included by reference to appendices or to site-specific, supplemental safety plans.

Safety equipment required on the job may be purchased by the company or by the workers, who are given an allowance to offset the expense. In either case, define proper safety equipment use. Write a statement that reinforces the general policy statement, and describe disciplinary action that may be taken if the required safety equipment is not used according to the plan.

► **Planning and rules**—Planning starts when equipment is specified or

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A written plan helps to ensure all hazards, safety rules, standard work procedures, company policies and proper use of required PPE are explained to the new worker.

Include a tear-out sheet for the worker to sign when each training step is completed. File these sheets as references to indicate when refresher training is due.

When new equipment is installed, when a new work site is included in the business, or when equipment has been modified, review the safety plan.

After an accident or near-accident happens, or when new information is learned that affects worker safety, a refresher training session may be required. Document the session as you would for all other training.

The effort expended to write a safety program and train workers is returned by lower worker injury rates, reduced turnover and reduced equipment damage or loss.

A formal safety and health program may be required by state and federal law. Check with the state occupational safety and health office to find out the possible requirements.

Having a formal safety program may allow you to negotiate lower insurance rates.

The effort spent to develop a safety program is worth the time and money in reduced injury and improved worker morale.

Some of a site-specific plan's features that may be required under Title 29 of the Code of Federal Regulations (29CFR) or other Occupational Safety and Health Administration (OSHA) rules are included in the following example. This example is not intended for any use other than educational.

#### Table of Contents

1. General safety policy statement.
2. Safety rules, shop and remote site.
3. Work site hazard information.
4. Housekeeping and sanitation.
5. Fire prevention.
6. Electrical safety.
7. RF safety.
8. Grounding safety and maintenance.
9. Battery bank and charger safety.
10. Personal protective equipment.
11. First-aid and evacuation procedures.
12. Accident reporting.
13. Proper lifting techniques.
14. Climbing equipment and safety.
15. Education and training, HAZCOM.

The site-specific safety and health plan requires a lot of thought and research. It can, and should be, the safety program's foundation.

The safety program should give the worker, in simple and understandable terms, the information needed to perform the job safely. The site-specific plan should give workers a process for informing managers of hazards and a detailed accident-reporting procedure. It should explain how to mitigate hazards that cannot be eliminated.

Once completed, the safety program should be reviewed by a professional.

Another information source is other local maintenance organizations' safety plans. Expect to pay for other

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organizations' information because the reuse of most safety plans prepared by professionals and consultants is protected by copyright or other restrictions.

Some sample chapters follow.

*Safety policy statement:*

The management of (your company or agency) recognizes the need for a safe and healthy work place.

Managers and workers share the work place safety responsibility.

The management accepts responsibility to identify work place hazards and to mitigate the hazards through physical protection, personal protective equipment and information that allow workers to understand and avoid hazard exposure.

The workers are responsible to fol-

low all work rules, train for and use standard work practices, use personal protective equipment and report hazards and accidents.

Failure to follow safety rules and standard work practices may be grounds for termination of employment.

*Work site hazard information:*

Place a copy of checklists and explanations of terms at the front or at the end of the chapter.

1. Physical hazards.

- A. Electrical.
- B. Chemical.
- C. Noise.

2. Hand and power tool use.

3. Ladders and scaffolds.

4. Driving policy.

5. Battery bank testing procedures.

6. Generator changeover procedures.

7. Generator refueling procedures.

Although these two sample chapters

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## Advice for multi-user site operators

Multi-user site operators should obtain copies of all users' safety plans.

Review these plans for conflicts with internal safety plans. (It is not normally the site operator's prerogative to approve or disapprove a user's safety plan.)

When conflicts are noted or when a user has no safety plan, review the contract with the user for possible liabilities.

Post site-specific safety plans and rules in plain view at each site.

At sites with battery banks or other hazardous equipment that requires personal protective equipment (PPE), post a copy of the specific work procedures for that equipment and list the PPE required.

Post a checklist or inventory of PPE, including first-aid kits, kept on the site.

Post a list of emergency telephone numbers or radio communications frequencies, and keep it up to date.

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- Remote Delinquent Subscriber Disable & Enable
- Out of Range Conventional Operation



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**CES**

## Common questions during a safety plan review

(1) Have you given local emergency and law enforcement officials a current, readable map to all of your sites?

(2) Are required safety items, such as first-aid kits, eyewash fountains, gloves and face shields, available?

(3) If technicians are dispatched alone to remote sites, does your plan have a procedure for check-

ing their status periodically?

(4) Do interlocks on multi-user sites send an alarm to a monitor and remove power when they are opened?

(5) Have you posted safety plans at all of the sites under your control?

(6) Is the emergency contact list current?

are by no means as complex and detailed as an actual site-specific health and safety plan, they show some of the subjects and a usable format.

By placing the procedures at the end of each appropriate chapter, changes caused by new equipment or methods can be made easily with little effect on

the rest of the safety plan. A copy of the procedures should be posted next to equipment to remind workers.

When multiple sites are covered by a single plan, use fill-in-the-blank style documents. They cost less, and they are easier to change. Almost any format works, as long as the workers can

understand the information.

The safety plan document should have a hazard communication (HAZCOM) appendix with any required material safety data sheets. Most small radio repair companies or user-operated repair centers do not handle enough hazardous chemicals to warrant a full HAZCOM program; nevertheless, check with the local occupational safety and health organization office to ensure the plan complies with the law. This office may be listed as a Department of Labor office.

The simplified sample format allows for changes in procedures, methods and work standards. Small business and small agency managers should be able to write an acceptable safety plan. Still, it should be reviewed by a safety professional or a state agency charged with worker safety.

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# Behind the FCC label on a land mobile radio

*Plenty of tests and paperwork must be completed before the FCC label is placed on a land mobile radio. Here are the procedures that must be followed before radio equipment reaches the marketplace.*

By Rex E. Miller

Transmitters, receivers and transceivers operating in the land mobile radio frequency bands all have one thing in common: an "FCC" label permanently affixed to the device.

Most radio dealers and users know that this label is the FCC's "stamp of approval," but few know the technical process required to obtain the right to affix the label to a land mobile radio.

## Label

Information on the label may consist of the grantee's name, which may identify the manufacturer, organization, individual or importer that provided technical data to the FCC demonstrating that the radio complies with the agency's technical standards.

The grantee is responsible for the radio's compliance with FCC rules and is the holder of the *Grant of Equipment Authorization* the FCC issues. The grant lists the grantee's name; FCC Device Identification Number, the FCC rule part(s) under which the radio is allowed to operate; equipment class; frequency range, power output; frequency stability and emission designator(s). The label's

When this article was written, Miller was a contract engineer with Waseca Technology, Waseca, MN.

Waseca Technology was acquired by ADC Kentrox, Portland, OR, in June 1993 and continues to operate as the Development Center of ADC Kentrox in Waseca.

Miller now is president of an EMI consulting company, TWS Consultants, in Waseca, MN; telephone 507-835-5749.

most important information is the *FCC Identifier* required by the commission's rules.

The identifier consists of a grantee code assigned by the FCC and a product code assigned by the grantee.

A grantee code consists of Arabic numerals, capital letters or a combination. Once a grantee code is assigned, the grantee continues to use it for subsequent equipment authorization applications.

The product code selected by the

code and product code. The term *FCC ID* must precede the identifier code. For a transceiver with a receiver subject to the verification process, which is typical of a land mobile transceiver, the term *FCC ID* precedes the FCC identifier required for the transmitter portion of the transceiver.

Example:

FCC ID XXX 0000  
| |  
| | Product code  
| |  
| | Grantee code

*The grantee applicant or assigned agent makes measurements to verify that the equipment complies with appropriate technical standards.*

grantee consists of Arabic numerals, capital letters or a combination, and may include a dash or hyphen. The number of numerals, letters, dashes and hyphens may not exceed 14, not including the 3-character grantee code. The product code is unique to the radio and cannot be used with another device associated with the same grantee code.

Additional information must precede the grantee and product codes. The term *FCC ID* must precede the grantee

A label for a stand-alone receiver must also include a statement pursuant to Part 15.19 of the FCC rules.

Separate FCC identifiers may be assigned to a device consisting of two or more sections assembled in a common enclosure. The FCC ID assigned to a transmitter section is preceded by the term *TX FCC ID*. The receiver section is preceded by the term *RX FCC ID*.

Refer to FCC Rule Part 2.925 for additional information.

## Authorization procedures

There are several procedures available for equipment authorization depending upon the type of radio.

► *Verification*—The most common procedure used with a transceiver's receiver portion is the verification procedure.

The grantee applicant or assigned agent makes measurements to verify that the equipment complies with appropriate technical standards. No forms or technical data are filed with

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#### FCC testing

The following information applies to equipment authorization testing for a typical land mobile FM transceiver.

Transmitter testing is done in accordance with FCC Part 2 and Part 90 rules using the type acceptance procedure. Receiver testing is done according to FCC Part 15 rules under *unintentional radiators* using the verification procedure.

► **Transmitter type acceptance**—A typical FCC type acceptance test report for a land mobile FM transmitter consists of the following technical tests:

(1) **Transmitter rated power output.** Both the dc power input and the RF power output of the final amplifier stage are measured.

(2) **Frequency response of transmitter audio modulating circuit.** This is a test of the overall transmitter audio modulation characteristics measured over the audio input range of 100Hz to 10,000Hz.

(3) **Audio response of audio filter.** This is a test of the transmitter's audio lowpass filter

by itself without the influence of other circuits. The response requirements change depending on the operating RF band as specified in FCC Part 2 and Part 90 rules.

(4) **Percentage of modulation vs. input voltage.** Modulation input level and frequency are varied in a series of tests to determine whether there is a combination that may cause overmodulation.

(5) **Transmitter spurious and harmonic outputs.** All transmitter unwanted harmonics and spurious signals are measured at the antenna output connector over a frequency spectrum equal to 10 times the carrier output frequency.

(6) **Transmitter occupied bandwidth.** This test measures out-of-band emissions occurring on a frequency or frequencies immediately outside the necessary transmission information bandwidth. This test must be repeated for each emission designator applied for on the equipment authorization application.

(7) **Frequency stability with variation in ambient temperature.** The RF carrier's frequency is measured in 10°C increments from -30°C to +50°C.

(8) **Frequency stability with variation in supply voltage.** The RF carrier's frequency is measured while varying the main power supply voltage  $\pm 15\%$  of nominal.

(9) **Spurious radiation attenuation.** This is a measurement of unwanted signals radiated from the transmitter through the air. Testing normally is conducted on an outdoor calibrated test range using calibrated antennas and test equipment.

(10) **Additional Information.** The test report should provide a circuit description, schematics, photos, FCC ID label artwork, operating manual, transmitter tune-up procedure and qualifications of the engineers who perform the tests. It should explain the functions of all active devices. The test report is filed with the FCC along with an application form, a filing fee and a filing fee form.

► **Receiver verification**—A verification test report is not filed with the FCC. Instead, it is kept in the grantee's possession.

A typical verification test report for the receiver portion of a land mobile transceiver consists of the following technical tests pursuant

to FCC Part 15 rules.

(1) **Antenna power conduction.** This is a test of conducted unwanted spurious signals that appear at the receiver's antenna terminal.

(2) **Radiated emissions.** These are unwanted signals radiated from the receiver through the air.

Using calibrated antennas, this test is performed on an FCC-approved test site. The range of radio spectrum searched depends on the radio frequency signals the receiver generates.

(3) **Report.** A report should be compiled that contains the technical test data, schematics, operating manual, circuit description and circuit block diagrams and retained by the grantee to show that the receiver complies with FCC rules.

(4) **Spurious signals.** If the receiver is powered from the public utility ac power lines, a measurement of spurious RF signals that the device conducts back into the ac lines must be made using specified *line impedance stabilization networks*.

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the FCC, although a test report should be compiled and kept on file by the grantee.

► **Type approval**—Type approval is an equipment authorization based on equipment measurements made at the FCC laboratory for a fee.

► **Notification**—The notification procedure requires the applicant or assigned agent to make measurements to determine whether the equipment complies with appropriate technical standards.

An appropriate form is filed with the FCC, and the agency may want a copy of the FCC label ID and equipment photos.

Notification is the most common procedure used to apply for Part 15 authorization for a land mobile stand-alone receiver. A filing fee is required along with a filing fee form.

► **Type acceptance**—To use the type acceptance procedure, the grantee applicant or assigned agent performs prescribed tests, compiles a test report and submits the test report and an FCC

form to the commission for review.

Type acceptance is the most common procedure for applying for Part 2 and Part 90 authorization for a stand-alone transmitter or the transmitter portion of a transceiver. A filing fee is required along with a filing fee form.

► **Certification**—Certification procedures apply to equipment authorization for devices designed to be operated without an individual license under FCC Part 15 rules.

The grantee applicant or assigned agent submits required test data along with appropriate forms to the FCC for review. This procedure is used to gain equipment authorization for low-power transmitters referred to as *intentional radiators*, which cover conventional transmitters and spread-spectrum devices. A filing fee is required along with a filing fee form.

#### **Data transmission**

Often, land mobile radios are used to send and receive data instead of voice or tones.

Some situations require that the transmitter's internal modulation control circuits be bypassed and an external modem or data generator be connected directly to the point in the radio where the RF carrier is modulated. The modulation control circuits thus are located in the modem-data generator.

When connecting this external device to a land mobile radio, modification of the radio's Type Acceptance Equipment Authorization is required, and additional test data must be submitted to the FCC.

#### **Conclusions**

FCC compliance testing for equipment authorization is a complex matter.

Calibrated test equipment and test sites are required, along with highly trained specialists. The FCC Identification Label attached to the land mobile radio may be small, but the technical testing, test report and associated paperwork behind it add up to a big item.



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# Narrowband channel signaling demands bandwidth efficiency

*Contrary to popular belief, reducing channel spacing and transmitter power as the FCC proposes to do in its spectrum refarming project will not increase spectrum efficiency. The technical reasons are many.*

By Dr. Gregory M. Stone  
and Karen Bluitt

Considering the tremendous worldwide pressures placed upon radio spectrum as a natural resource, the introduction of adaptive communications philosophies such as that embodied by Motorola's Astro digital technology represents the dawn of a new era in personal communications.

Bandwidth- and spectrum-efficient technologies and architectures are soon to be mandated by the FCC for state and local government and business licensees in the private land mobile radio services in the agency's far-reaching spectrum refarming *Notice of Proposed Rulemaking* (NPRM) in PR Docket 92-235 and for federal agencies through similar efforts by the National Telecommunications and Information Administration (NTIA).

Stone is a senior associate with the professional services firm of Booz-Allen & Hamilton, McLean, VA. He holds a Ph.D. in electrical engineering; he is a Fellow in the Radio Club of America; and he is chairman of the IEEE Vehicular Technology Society's Propagation Committee.

Bluitt is a principal engineer with Sparta, a high-technology research and development company. She holds a B.S. in computer science and an MBA in management science. She is a member of the IEEE, ACM and Society of Women Engineers.

The opinions expressed in this article are solely those of the authors and do not necessarily represent those of their employers or other staff members.

Similarly, the deployment of digital cellular telephone, digital personal communications services (PCS) and wireless local area networks will be based upon the exploitation of such advanced technologies.

Moreover, the standards-setting pro-

m multimedia digital technologies. Spectrum refarming and Project 25 will have a profound effect upon the features and limitations of digital technology that reaches the field.

## Worldwide

Internationally, multiple programs to develop radio communications technology are based upon *efficient* spectrum use.

One such program is the development of Future Public Land Mobile Telecommunications Services (FPLMTS), for which a standard is expected by 1994-1995, and for which equipment is expected to be fielded by 1995-1996.

Two other programs are the Aircraft Correspondence Service (ACS) and low-earth-orbiting satellites systems (LEOSS).

All three compete for the spectrum resource.

In an amusing way, the new era brings with it a "new" terminology that really is only an echo from radio technology's history.

These days, the word "wireless" has replaced "radio" in descriptions of personal communications services. Radio, in the earliest days of Hertz and Marconi, was referred to as "wireless."

Another peculiar twist is that, with the advent of this year's "new" technology, what was referred to as *digital* last year now is described in marketing literature as *analog*. This year's digital technology, you see, is the one and only "true" digital technology.

PCS, ANDC, FPLMTS, ACS,

Table 1—Bandwidth efficiency values.

| Bandwidth Efficiency Value | Required Carrier-to-Noise Ratio (CNR) |
|----------------------------|---------------------------------------|
| 1.0 b/s/Hz                 | 1.0dB (1.25)                          |
| 2.0 b/s/Hz                 | 5.0dB (3.15)                          |
| 3.0 b/s/Hz                 | 8.0dB (6.3)                           |
| 4.0 b/s/Hz                 | 12dB (15.8)                           |
| 5.0 b/s/Hz                 | 15dB (31.6)                           |
| 6.0 b/s/Hz                 | 18dB (63)                             |

**Note:** These values reflect rounding.

cess is not standing still. In the realm of radio communications for public safety organizations (law enforcement agencies, fire departments and emergency medical services), the Associated Public-Safety Communications Officers (APCO), a South Daytona Beach, FL-based trade association, is spearheading *Project 25*. The project's objective is to develop and promulgate a standard for the next generation of advanced narrowband digital communications (ANDC) for public safety radio communications.

No wonder we are on the verge of a new era, a communications revolution with a voracious appetite for the emerging proliferation of low-cost,



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...Follow the Leader

LEOSS and the rest of the alphabet soup digital radio communications services depend upon the successful commercial exploitation of bandwidth- and spectrum-efficient technologies. Most of these services depend upon powerful embedded signaling that, in concert with stringent voice quality objectives, places high demands on any technology—let alone those that are bandwidth-efficient.

#### Promise and peril

With spectrum refarming comes the *great promise*: the expansion of available discrete channels by 300%-500%.

Regardless, is increased channel availability the real benefit of spectrum refarming? No.

The real promise of refarming is the stimulation of advanced digital communications technology that will revolutionize personal communications.

If developers are given an incentive

to pursue bandwidth- and spectrum-efficient technologies, one of the many benefits likely to result from the proliferation of advanced digital communications technology is the use of fully

efficiency and *bandwidth efficiency* with respect to narrowband radio technology.

*Bandwidth efficiency* refers to a given channel bandwidth's information capacity. Researcher Claude Shannon has published extensive studies of bandwidth efficiency, and a given bandwidth's information capacity often is referred to as its *Shannon channel capacity*.

Systems using modulation and channel coding techniques operating at data rates significantly less than the Shannon channel capacity are not as bandwidth-efficient as those using methods that approach the Shannon limit.

In contrast with bandwidth efficiency, spectrum efficiency refers to a *mission or use* and takes into account much more than mere bandwidth quantity; nevertheless, unless channel band-

**Table 2—Bandwidth efficiencies for several levels of quadrature amplitude modulation.**

| Modulation | Theoretical Bandwidth Efficiency | Attainable Bandwidth Efficiency |
|------------|----------------------------------|---------------------------------|
| 4-QAM      | 2 b/s/Hz                         | 2 b/s/Hz                        |
| 16-QAM     | 4 b/s/Hz                         | 3.8-4 b/s/Hz                    |
| 64-QAM     | 6 b/s/Hz                         | 5.7-6 b/s/Hz                    |

embedded signaling and the integrated transmission of voice and multimedia digital data.

#### Spectrum and bandwidth efficiency

In the spectrum refarming *NPRM*, the FCC refers to both spectrum-efficient technology and "narrowband" technology. It is important to recognize the differences between *spectrum*

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width is used effectively, ultimate spectrum efficiency can never be accomplished.

### Efficiency example

For example, consider the relative spectrum efficiency of using AM broadcast band frequencies for radiopaging in an urban area.

Even if bandwidth-efficient technology is employed, using the medium wave band for urban paging is not spectrally efficient because the 160-meters-or-longer wavelengths are unsuitable for communications when building penetration is important.

Spectrum efficiency is *multidimensional*.

In narrowband frequency-division multiple-access (FDMA) systems and in hybrid systems with FDMA as part of a complex multiplexing scheme, bandwidth efficiency is a necessary component of spectrum efficiency. In the case of FDMA, spectrum efficiency may be viewed as an

integration of bandwidth-efficient technology using the ideal wavelength for transmission along with optimum channel coding and power densities, controlled interference frequency reuse and trunking.

What are the requirements of the underlying bandwidth-efficient technologies? Why are they important? They are important because the full promise of spectrum-efficient technology will not be delivered unless FCC rules are adopted that heavily favor the cutting edge of technological advancement. Instead, there will be a limited improvement and a lot of marketing hype.

The basis for this assertion is the Shannon limit.

### Shannon limit: a power trade-off

With all of the excitement surrounding the wireless digital revolution, often one loses sight of the basic principles that dictate what techniques work and how well they perform in the physical world.

Digital transmission is most efficient when the source data and the channel use proper coding techniques.

Under those conditions, a channel of  $W$  Hz bandwidth has a capacity  $C$  (for various RF carrier-to-noise ra-

Table 3—The relationship between bandwidth efficiency and power requirements for practical QAM systems.

| QAM Bandwidth Efficiency | Carrier-to-Noise (CNR) Ratio Required |
|--------------------------|---------------------------------------|
| 4-QAM @ 2 b/s/Hz         | 14dB                                  |
| 16-QAM @ 4 b/s/Hz        | 20dB                                  |
| 64-QAM @ 6 b/s/Hz        | 26dB                                  |

Taken as a composite, an FDMA-based communications system using optimum bandwidth-efficient technology, in addition to trunking and controlled interference frequency reuse, may be viewed as a "spectrally efficient" system.

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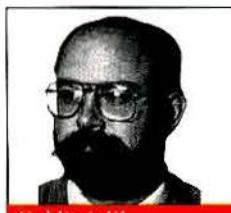
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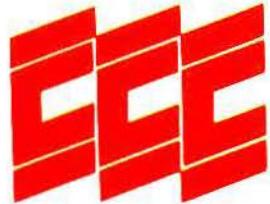
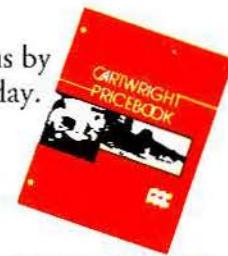
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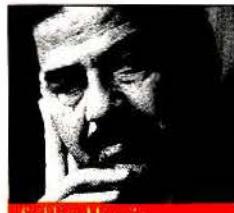
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tios [CNRs]) that may be calculated using Shannon Channel Capacity Theorem contained in the following equation:

$$C = W \log_2(1 + \text{CNR})$$

From this equation, bandwidth efficiency values from 1.0 b/s/Hz to 6.0 b/s/Hz have been calculated and are

shown in Table 1 on page 22.

#### Two bandwidth objectives

The FCC *NPRM* proposes two bandwidth objectives, a 4.0kHz occupied bandwidth within a 5kHz channel and a 5.0kHz occupied bandwidth within a 6.25kHz channel.

A 4.0kHz occupied bandwidth with an RF CNR of 25 (14dB, which is

typical in land mobile radio) has a theoretical data rate capacity of 18.8 kb/s, which equates to a bandwidth efficiency of 4.7 b/s/Hz. At an occupied bandwidth of 5.0kHz, the channel information rate increases to 23.5 kb/s.

Unfortunately, in practice, it is not possible to obtain the theoretical Shannon channel capacity. Still, it is possible to use channel coding and to fully exploit advances in digital signal processing-based (DSP) "brick wall" filtering that permits a highly efficient use of bandwidth.

Note the relationships among information capacity, bandwidth and power.

The Shannon theorem indicates that the easiest way to increase channel information capacity is to increase bandwidth  $W$ , and the most difficult way to increase the channel information rate is to increase the power. As a way of increasing the channel information rate, a power increase is at a disadvantage because channel capacity only increases with the logarithm of power.

#### Choices

Keep these choices in mind when you think about the proposals being advanced by the FCC and other regulatory bodies to restrict bandwidth and to limit power, ostensibly to promote increased bandwidth efficiency and spectrum efficiency. *If you limit the power, you must increase the bandwidth, or if you limit the bandwidth, you must increase the power.*

The key to effective exploitation of bandwidth efficiency, assuming that adequate power is permitted, is through the use of multilevel (m-ary) modulation or coding in which many information bits are encoded into each symbol transmitted. Thus, although in binary systems the information bit rate is equivalent to the transmitted baud rate, with m-ary coding the information rate conveyed is higher than the symbol baud rate.

The most promising m-ary technique is quadrature amplitude modulation (QAM). With QAM, bit rate capacity is determined by the number of phase and amplitude levels.

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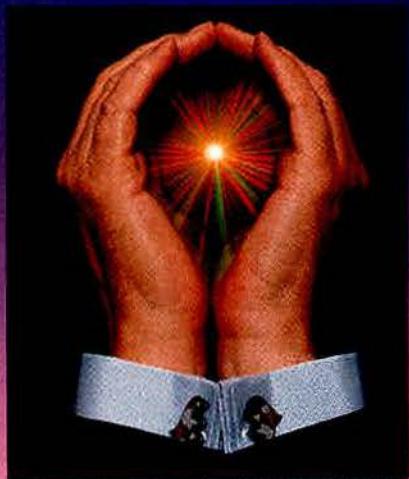
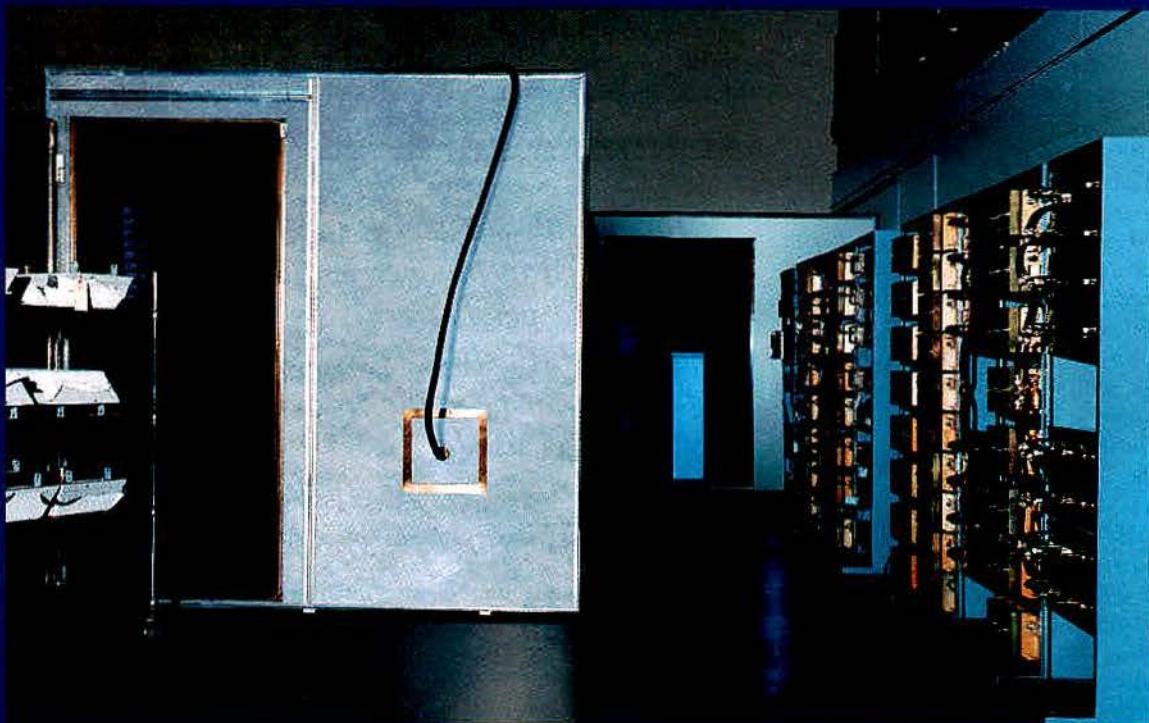


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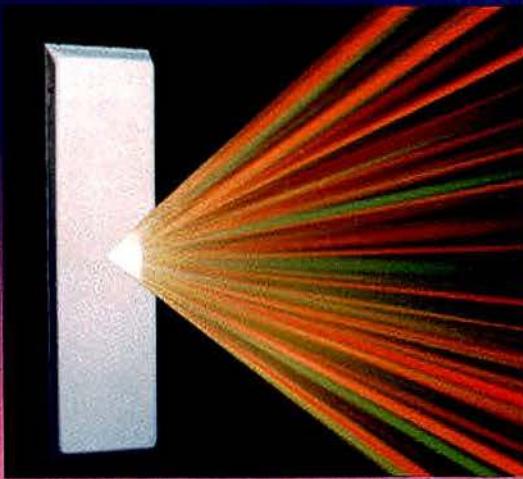
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pi/4 DQPSK modulation, even though as a form of QAM, it really only represents the entry level of bandwidth efficient modulation.

#### Coding level

Bandwidth efficiency expressed in bits per second per hertz bandwidth (b/s/Hz) is a function of the coding level used. In this discussion, it is assumed that the coding and information transfer rate of the symbols transmitted do not exceed the Nyquist rate. Thus, with 4-QAM (four-level QAM), the theoretical efficiency is 2 b/s/Hz.

These relationships are presented in Table 2 on page 24.

As shown in Table 2, 16-QAM would have a maximum theoretical bandwidth efficiency of 4.0 b/s/Hz. The 64-QAM mode would have an information capacity of 6.0 b/s/Hz. Within the FCC-proposed occupied bandwidths of 4.0kHz or 5.0kHz, effective data rates of at least 22.8 kb/s can be achieved with 64-QAM.

For practical QAM systems, the re-

lationship between bandwidth efficiency and power requirements in terms of carrier-to-noise ratio in a double-sided Nyquist bandwidth that

nary or even 4-ary signaling is fairly good, very high bandwidth efficiencies require significant power increases.

In this example, to use 4-QAM initially and then to migrate to 16-QAM and maintain the same error performance, a 6.0dB (factor of four) increase in power is required. Of course, narrowband systems have greatly reduced detection bandwidths, thus accruing a "power" advantage.

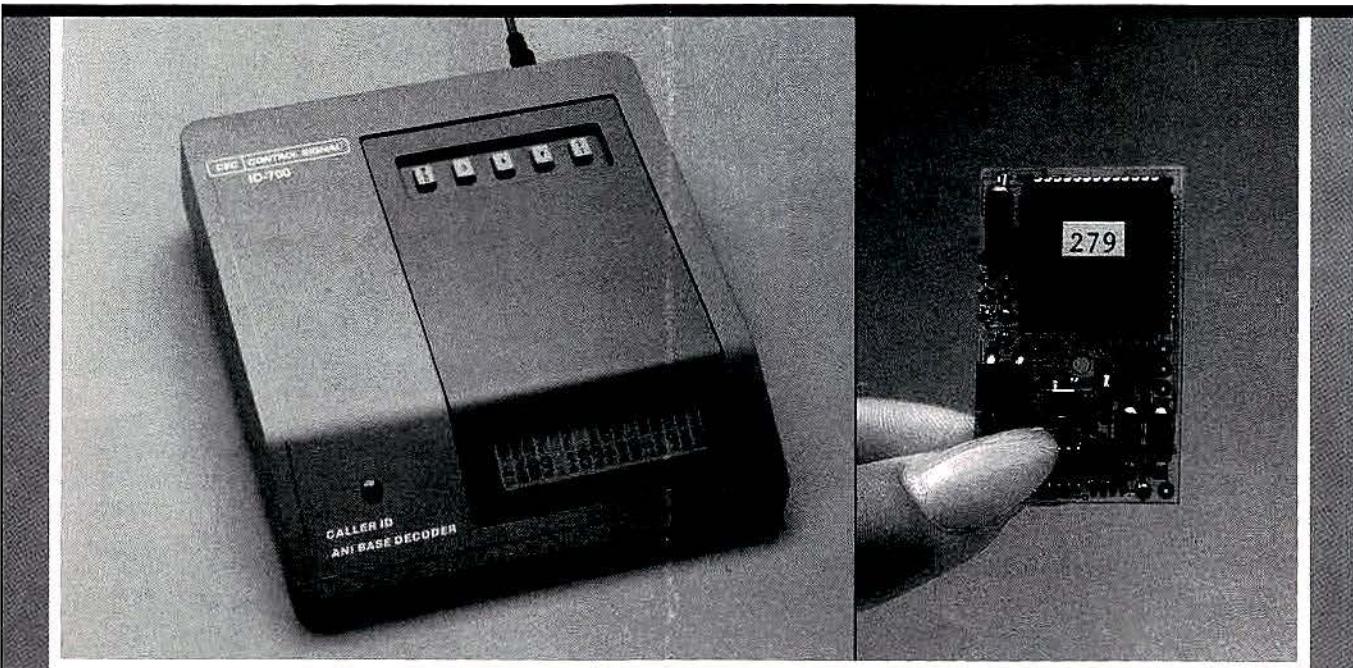
Detractors of narrowband and bandwidth-efficient technologies claim that a mobile communications channel is characterized by phase and amplitude distortions of such a degree that they make the use of "high-level" very bandwidth-efficient modulations, such as 16-QAM or better, impossible.

Such claims are indefensible and ignore the tremendous advancements in phase and amplitude perturbation correction made during the last 20 years that allow a complex Rayleigh-log normal channel to become a first-order time-invariant Gaussian channel. Such channel linearization techniques

equals the transmit symbol rate for a 10-6 bit-error-rate (BER) are presented in Table 3 on page 26.

#### Efficiency vs. power

The figures in Table 3 show that although the power efficiency of bi-



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as feed forward signal regeneration (FFSR) and transparent tone in-band (TTIB), developed in the early 1980s by Dr. Joseph McGeehan and Dr. Andrew Bateman, are the best examples today of such practices and are proven in their effectiveness.

In McGeehan's 1980s FFSR-TTIB research, the use of 16-QAM modulation for very low error (10-6 BER)

transmission at approximately 13 kb/s in a 3.4kHz occupied bandwidth was demonstrated at 400MHz under Rayleigh faded conditions at a vehicle velocity of approximately 100 km/h. McGeehan obtained this performance level without using any error detection and correction (EDAC) and simply relied upon the FFSR-TTIB channel linearization techniques to provide a

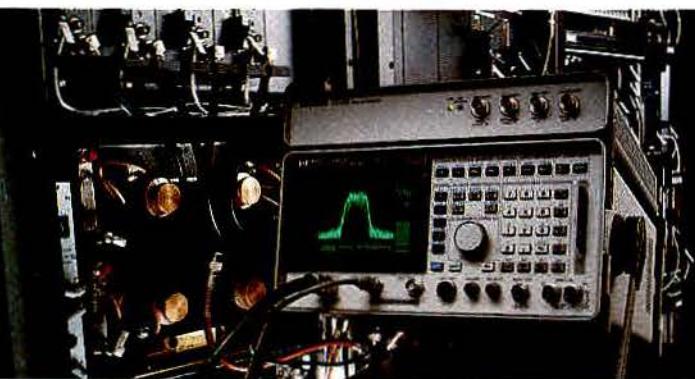
solid time-invariant channel.

#### Refarming-driven technologies

The research is relevant to spectrum refarming because the FCC is proposing major changes in how private land mobile radio (versus public or radio common carrier) services below 512MHz are regulated and how they operate.

Two emission masks are proposed, one for 5.0kHz channel spacing in the 72MHz-222MHz frequency bands, and a second emission mask for 6.25kHz channel spacing in the 412MHz-520MHz frequency band. Occupied bandwidths are limited to 4.0kHz with 5.0kHz channel spacing and 5.0kHz with 6.25kHz channel spacing.

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*The proposed narrower FDMA channels do not require the use of digital technologies.*

Under this scheme, the proposed emission masks will provide 40dB of attenuation at the edge of the authorized channel (not bandwidth), 50dB of attenuation at the edge of the authorized bandwidth of the adjacent channel and 65dB of attenuation beyond those points.

#### Digital not necessary

The proposed narrower FDMA channels do not require the use of digital technologies. Depending upon how the power level issue is resolved, analog single-sideband may prove to be the only really viable technology. In fact, single-sideband in the form of amplitude companded single-sideband (ACSSB), a 50-year-old technique, is a likely and potentially aggressive candidate that may provide cost-effective narrowband communications in these narrower channels.

To implement digital bandwidth-efficient techniques that can support reasonable data rates such as 9.6 kb/s in a 4.0kHz or 5.0kHz occupied bandwidth in an economical way, vendors



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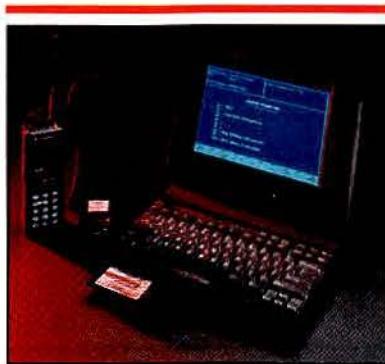
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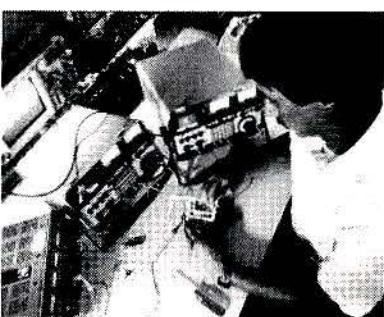
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may be expected to use a linear system architecture.

Methods may include DSP-based direct conversion or up-conversion linear frequency translation in concert with high-level digital modulation such as 16-QAM and may use certain adaptive channel linearization techniques such as McGeehan's TTIB with FFSR. The result would be a very bandwidth-efficient digital implementation of a direct linear frequency conversion with a bandwidth occupancy at radio frequency proportional to the baseband bandwidth that has been frequency-translated. Even then, QAM power requirements must be met.

### Multimedia applications

To accommodate emerging multimedia applications involving digital voice, digital text and digital imagery and video, these bandwidth-efficient digital implementations are necessary to exploit the very limited occupied bandwidths proposed with either the 5.0kHz or 6.25kHz channels. Such multimedia applications easily could necessitate the use of 64-QAM, which could provide information transfer rates as high as 24 kb/s to 30 kb/s in the FCC-proposed narrowband channels.

Effective use of narrowband channels requires the use of bandwidth-efficient techniques that demand more power than their inefficient counterparts. To support the demands of the user population for multimedia information transport, very highly bandwidth-efficient techniques are required.

There is a need for feed-forward automatic frequency control techniques and DSP-controlled power amplifiers to maintain system integrity.

Most important is the absolute acceptance and use of linear system architectures. The pioneering work performed during the last decade by McGeehan and Bateman from the University of Bristol in the UK only scratches the surface of the potential of linear transmission. Only by linearizing the heretofore corrupted wireless environment will the full exploitation of the works of Shannon and the maximum use of the radio spectrum resource be allowed.



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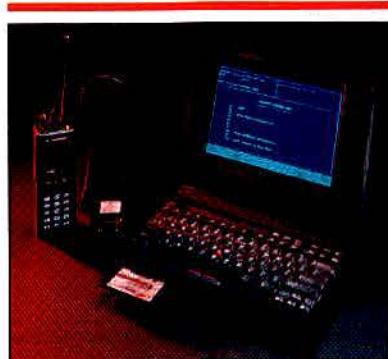
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*Modifications to Motorola and General Electric mobile radios convert them into repeaters suitable for emergency use. The modifications only take a few minutes and can be reversed easily to restore the units for mobile service.*

By Terry W. Ellis

When an emergency calls for an intermittent-duty repeater, it can be made by modifying a GE MASTR II mobile radio or a Motorola Mitrek mobile radio in about 30 minutes. Figure 1 to the right is a block diagram that shows the principle elements of the conversion.

The modification requires only a few parts, which are listed on page 42. The modification works for lowband VHF, highband VHF and UHF frequencies.

The modified mobile radio can be used as a mobile or base repeater with two antennas or with one antenna and a duplexer.

The intermittent-duty repeater can be used with or without continuous-tone controlled squelch system (CTCSS) tones. Motorola calls CTCSS private line (PL). GE calls CTCSS channel guard (CG).

The repeater converts back to a mobile radio in no more than 10 minutes.

Use a complete mobile radio, one with a control cable, speaker, control head and all mounting brackets. These can be mounted on a wooden board or

on the unit's top cover.

Ac or dc cooling fans and a power supply are needed if the unit is to be used as a base repeater.

## Modification kit

The modification kit consists of a 12Vdc relay, power n-channel metal oxide semiconductor field effect transistor (MOSFET), dropping resistors

rated from the receiver, and each must be provided with separate inputs.

The transmitter must be prevented from switching off the receiver when the transmitter keys.

The receiver is configured to key the transmitter using an output from the CTCSS board on a unit that has one. On a non-CTCSS Motorola Mitrek, an output is taken from the junction of R422 and C434. On a GE MASTR II, the output is taken from the R.U.S. connector. This output triggers the n-channel power MOSFET gate, which in turn keys the transmitter by grounding the push-to-talk (PTT or sec PTT) line through the relay. The power MOSFET isolates the transmitter from the receiver. (See Figure 2 on page 38.)

R422 and C434. On a GE MASTR II, the output is taken from the R.U.S. connector. This output triggers the n-channel power MOSFET gate, which in turn keys the transmitter by grounding the push-to-talk (PTT or sec PTT) line through the relay. The power MOSFET isolates the transmitter from the receiver. (See Figure 2 on page 38.)

The receiver audio is taken from the speaker output and used to modulate the unit's exciter. Capacitors isolate the two systems (receiver and transmitter audio). The volume control sets the 100% modulation deviation to 3.5kHz.

## Motorola Mitrek

The Motorola Mitrek is easier to convert than the GE unit because the CTCSS board (HLN 4181 A) encodes and decodes simultaneously.

The modification kit can be mounted on a small circuit board, either etched or wired point to point. Wiring for the

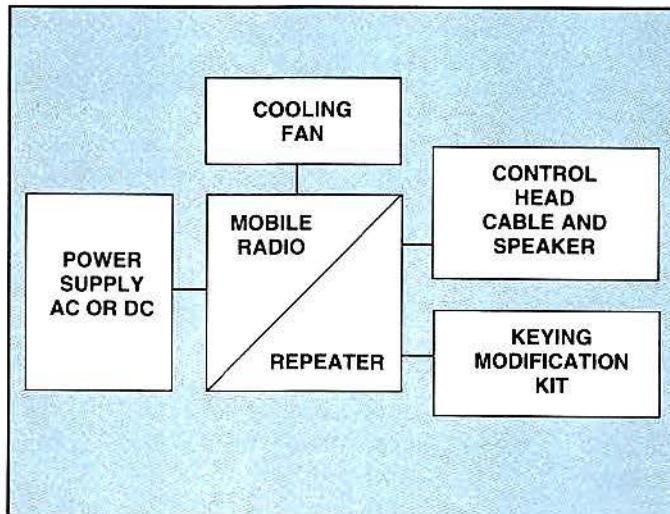


Figure 1. The principle elements for converting a mobile radio into a repeater include a power supply, a cooling fan, a control head cable and speaker and a keying modification kit configured as shown.

for the MOSFET gate input and, for the GE mobile, a capacitor to smooth out the gate pulse and couple audio to the exciter. The Motorola Mitrek has isolation capacitors in its audio circuit.

## Theory

To convert a mobile unit into a repeater, the transmitter must be sepa-

Ellis is a radio technician with City/County Communications, Spartanburg, SC.



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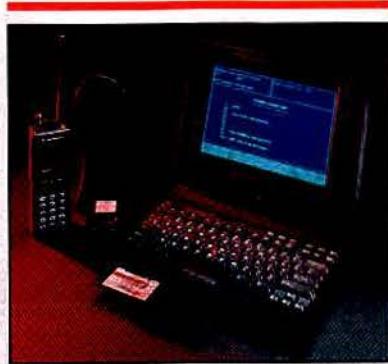
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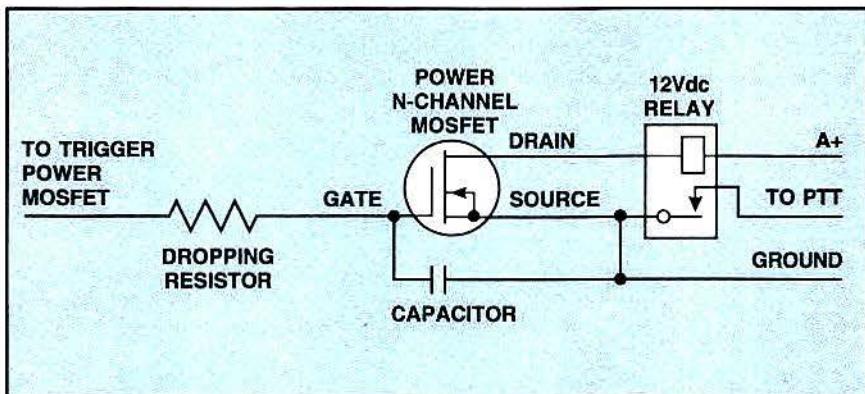


Figure 2. Receiver output triggers the transmitter by grounding the PTT line through a power MOSFET and relay for isolation. The text explains where in the radio to connect for receiver output.

kit is plugged into the receiver and transmitter metering sockets. (See Figure 3 on page 40.) Then the kit is placed within the unit.

The modification kit should be shielded as much as possible to exclude stray RF and to prevent intermodulation. All normal grounding and shielding practices should be observed.

Diode CR2 on the interconnect board and diode CR2 on the receiver board either are cut, or one side of each diode is lifted from the board. Opening these circuits isolates the receiver from the transmitter by opening the audio mute line and the sec PTT line.

Solder the only wire that does not go to the metering socket to pin 30 of integrated circuit (IC) U1 on the

CTCSS board. This wire is the lead that goes to the power MOSFET gate.

If no CTCSS board is installed, then take the gate input from the junction of R422 and C434 on the receiver board.

The wiring for the transmitter metering socket J1002 is pin 2 ground; pin 7 A+; pin 9 PTT low; and pin 14 microphone high.

The receiver metering J1002 has only one output, pin 9 receiver audio, which goes to the transmitter metering socket pin 14 microphone high, as shown in Figure 3.

The modification kit hooks up to the metering socket as follows (See Figure 4 on page 40.):

- J1002 pin 7 A+ to relay coil and drain.
- J1002 pin 2 ground to source and common on the relay.
- J1002 pin 9 PTT low to the normally open contact on the relay.
- U1 pin 30, the active high detect from the CTCSS board, to the gate and dropping resistors.

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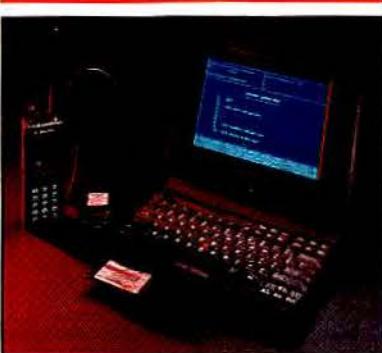
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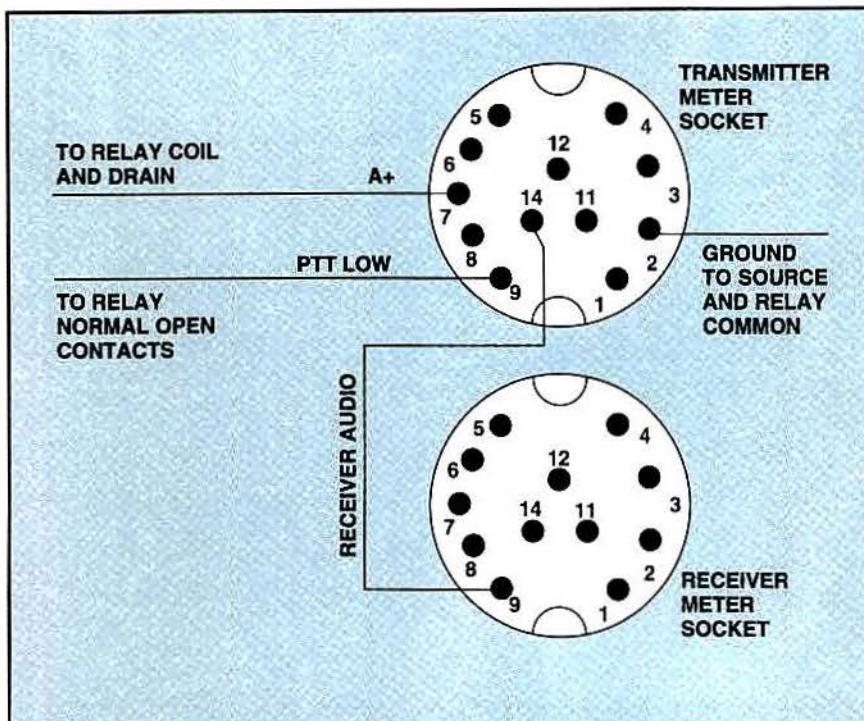


Figure 3. Wiring for the modification kit plugs into the Motorola Mitrek receiver and transmitter metering sockets as shown.

The transmitter modulation is set by the volume control for 3.5kHz maximum deviation.

## GE MASTR II

On the GE MASTR II, two circuit runs on the control board must be cut. One is at U901 pin 6 Rx mute. The other is at pin 7 Rx OSC control.

Connect a jumper from J903 pin 11 10V reg to J903 pin 12 Rx OSC on the receiver board.

Cut two circuit runs at J908 pin 8 delay PTT on the receiver CTCSS board.

If CTCSS will not be used, the input

signal for the power MOSFET's gate can be taken from the carrier activity sensor, CAS J904 pin 9, or from the receiver unsquelch sensor, RUS J904 pin 8. PTT for the relay normally open contact is taken from J908 pin 8 delay PTT.

If the transmitter has a CTCSS tone, another CTCSS board, either the 19D432500G1 or the 19C331044G1 (both of which are smaller encode-only boards) is needed. The additional CTCSS board is connected as follows:

□ P908 pin 4 10V reg to P907 pin 4 10V reg.

□ P908 pin 6 delay PTT to P907 pin

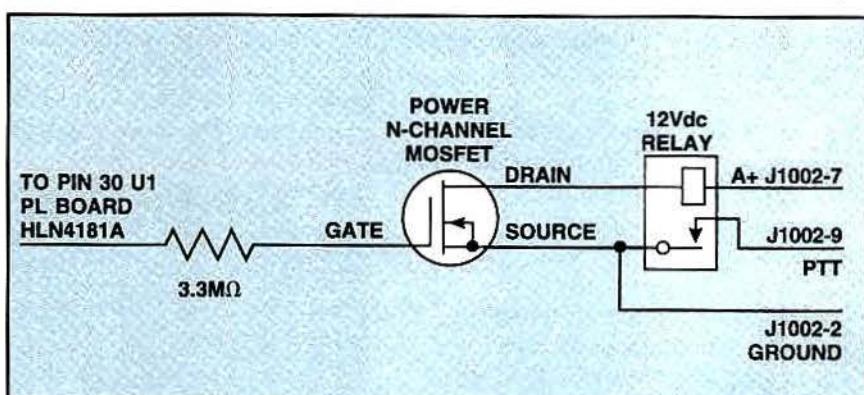


Figure 4. The modification kit connects to the Motorola Mitrek socket pins as shown.

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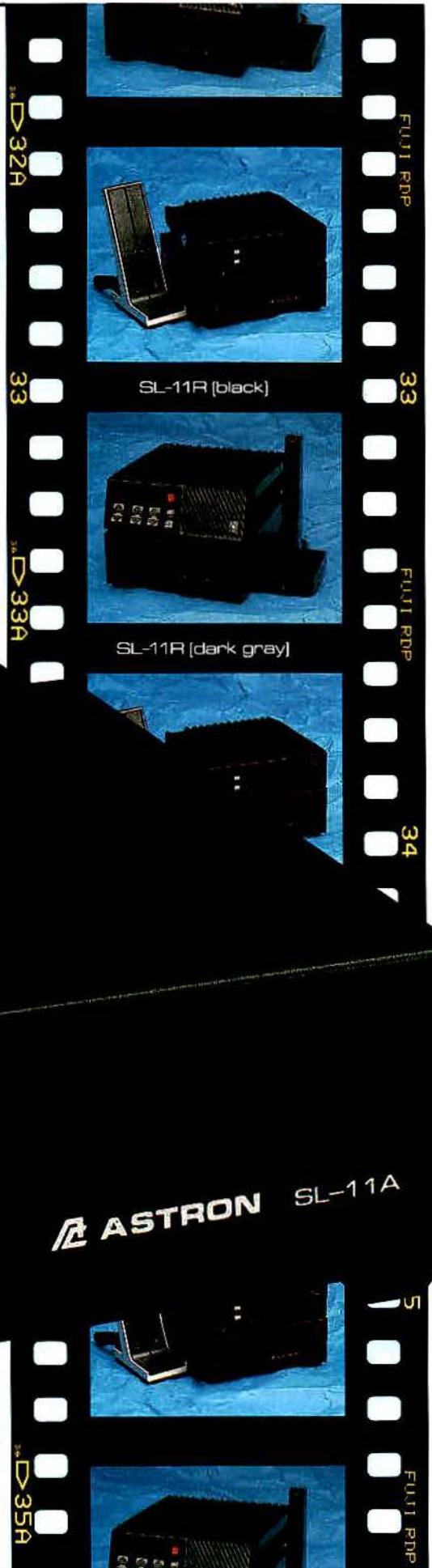
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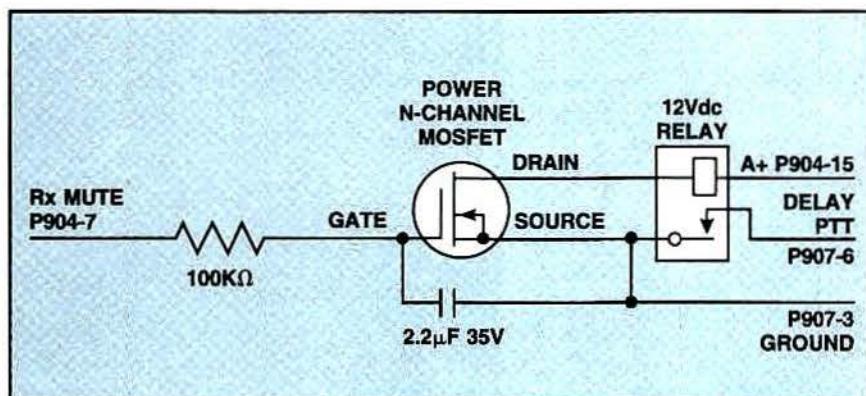


Figure 5. The modification kit connects to the GE MASTR II as shown. The  $2.2\mu\text{F}$  capacitor smooths the gate pulse.

#### 6 PTT.

P908 pin 7 PL tone out to P902 pin 2 PL tone HI.

P908 pin 9 A to P907 pin 3 A-.

The keying modification is connected as follows:

P904 pin 15 A+ to relay coil and drain on the power MOSFET.

P904 pin 7 Rx mute through resistor ( $100\text{k}\Omega$ ) to the power MOSFET gate.

P907 pin 3 A- to source and common on the relay.

P907 pin 6 PTT to normally open contact on the relay.

The  $2.2\mu\text{F}$  capacitor is connected to the power MOSFET's gate and ground to smooth the gate pulse. (See Figure 5 above.) With this modification, the control head microphone can be used as a local microphone.

A  $0.47\mu\text{F}$  35WV capacitor goes be-

tween J904 pin 19 speaker HI and J902 pin 6 MIC HI for isolation between the transmitter audio and receiver audio.

The volume control sets the modulation level to 3.5kHz.

The repeater made from a modified Motorola Mitrek does not have audio that sounds as good as the audio from the repeater made from a modified GE MASTR II.

To improve the Motorola unit's audio, insert another CTCSS filter in line with the receiver's audio output and adjust the modulation control so more drive is required to modulate the transmitter to 3.5kHz.

The Motorola unit is more prone to intermodulation than the GE unit in this configuration. Adding filtering to the Motorola receiver's front end helps to alleviate the intermod. The front end from a GE MASTR II has been used successfully for this purpose.

The intermittent-duty repeater is for emergency use only, not for everyday use.

#### Parts list

1. Mobile radio: GE MASTR II or Motorola Mitrek.

2. CTCSS tone board (if needed): Two 19D432500G1 for GE MASTR II or one HLN 4181A for Motorola Mitrek.

3. Power n-channel MOSFET: Radio Shack No. 276-2072 OIRF-511 or equivalent.

4. 12Vdc relay: Radio Shack No. 275-241 01 AMP SPDT micro or equivalent.

5. Circuit board: phenolic for point-to-point wiring or printed.

6. Capacitor:  $0.47\mu\text{F}$  35WV (for GE MASTR II).

7. Power supply: 35A Astron RS-35 or equivalent, adjusted to the power level desired for the repeater.

8. Cooling fans: Ac or dc, depending on the installation.

9. Adapter or cables: The type required to connect the antennas or duplexer.

10. Resistors:  $1\text{M}\Omega$ ,  $1.1\text{M}\Omega$ , OHN4M (Motorola),  $100\text{k}\Omega$  (GE MASTR II).

11. Wooden board: To mount radio, power supply and modification kit. (GE MASTR II.)

12. Metering plug: 1-80754A26. (Motorola.)

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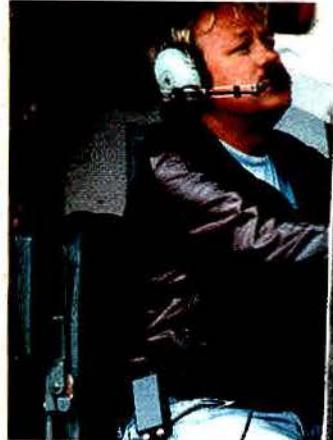
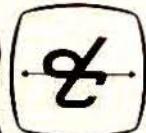
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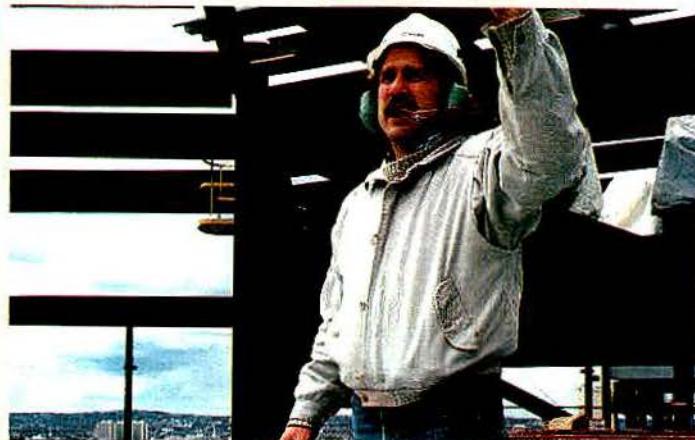
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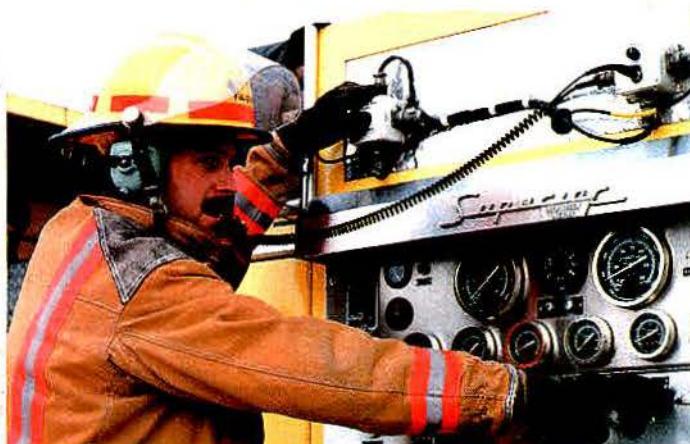
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# Fried green transistors

*The benefit of having a system diagram at hand for a service call at oh-dark-thirty outweighs the time and trouble it takes to draw one during the installation or during the first non-emergency visit to a new customer.*

By Mike Mekelburg

I arrived on the scene at 2 a.m.

It was an emergency after-hours call-out, the last of several that night for me. No one in the city had anticipated the extent of damage wreaked by a sudden sky-splitting thunder-

storm, and on-call service technicians were stretched to the limit, and beyond.

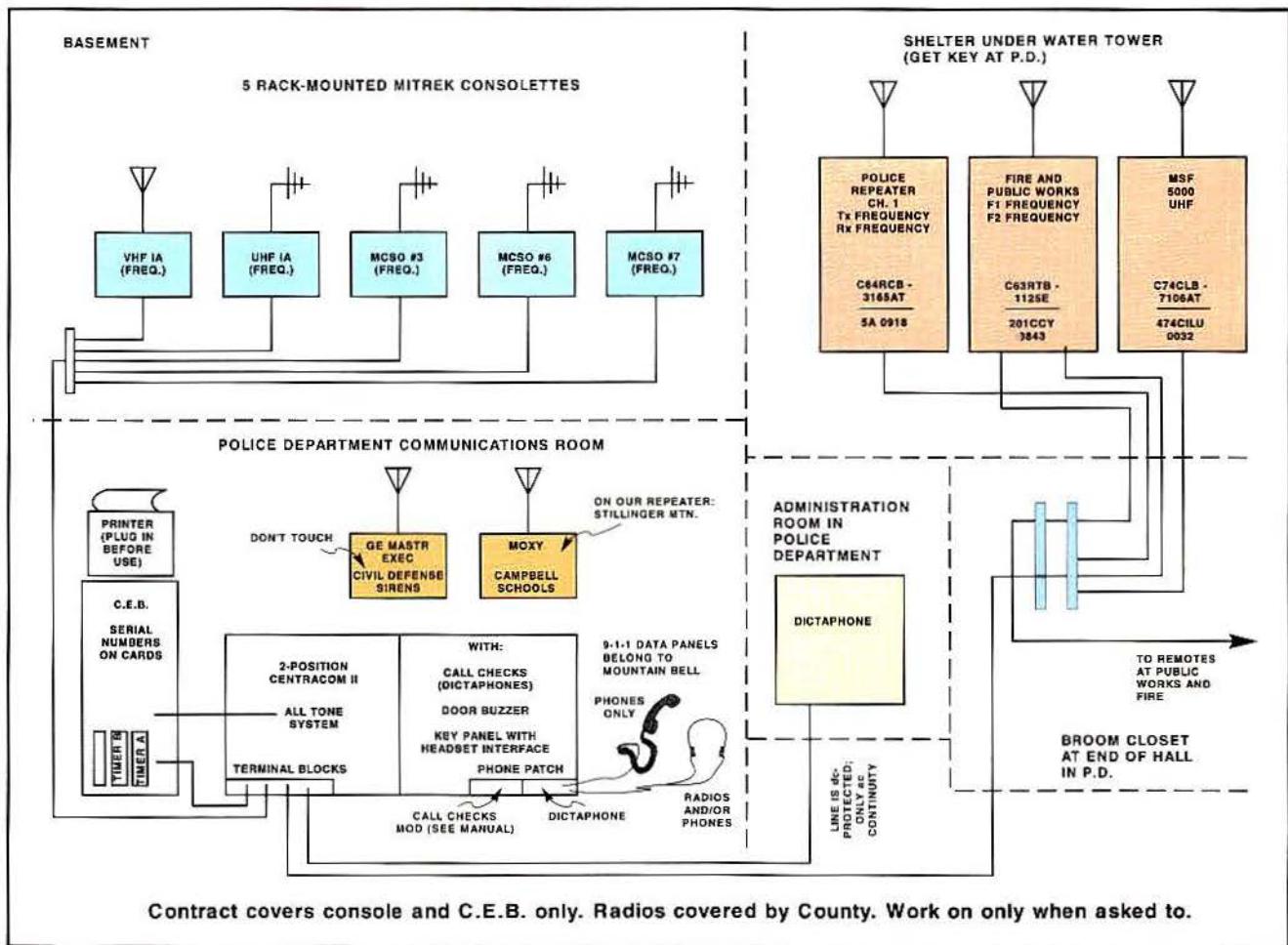
The contracted technician for the police communications center was knee-deep in smoking silicon halfway across town, so I was called out of desperation by a frazzled duty sergeant.

The station house was bathed in inky darkness as I parked my service van on

the quiet street. I walked to what looked to be a front door and rapped on the glass.

After several attempts, I used my penlight to peer inside the unfamiliar space. Frustration and fatigue drove

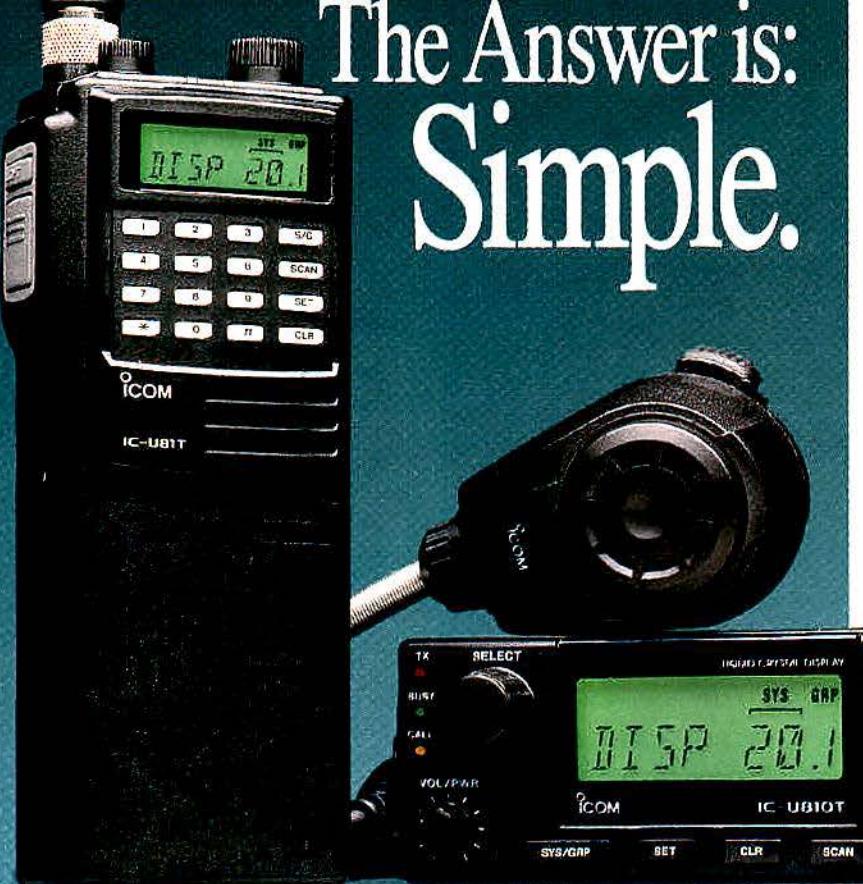
Mekelburg is lead technician at Confidential Communications Services, Flagstaff, AZ.



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me to give the door a tug. It almost hit me in the nose.

"Hello," I called into the black hallway. No answer. Odd, I thought. I could waltz in and rip-off a police station, if so inclined.

The beam from my penlight landed on recognizable terrain. A single-position dispatch console came into view.

I lipped the penlight and set to work extracting a T/R module. What awaited was not for general viewing pleasure.

Spaced in an orderly fashion across a green CMOS-sensitive circuit board were cratered surface-mount chips and popped transistors. Random inspection of other boards proved similar results. A direct hit, no doubt, or very shoddy

protection.

A car engine idled in the distance.

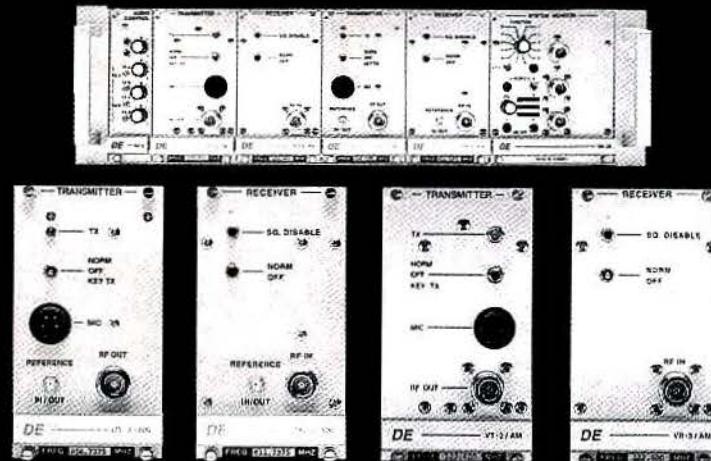
I carefully made my way to the back of the eerily empty building and stepped into the night air. A lone squad car sat in the center of a fenced parking lot. The duty sergeant stood alongside the vehicle while a plainclothes dispatcher sat behind the wheel, using the mobile two-way as a makeshift comm center. Mercifully, he dealt with a department that has only 10 squads.

The sergeant spotted me and led the way back to the violated dispatch console. I needed information because it was my first time on the premises—and looked to my only source. I asked where the radio base was.

The officer waved his flashlight onto

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*Spaced in an orderly fashion across a green CMOS-sensitive circuit board were cratered surface-mount chips and popped transistors.*

the apparatus before us. "You're looking at it," he said.

"No-no," I countered. "This is audio and dc control. There's copper from here to a transmitter-receiver box somewhere. And then coaxial cable to an antenna."

"Really? Well, the antenna is on the roof," he informed. "Bunch of 'em."

"And where do the cables lead to?"

"Phhf. Right here. Don't they?"

I rubbed the back of my neck and sighed. "OK. Where's your system diagram?"

"Excuse me?" he replied.

I explained what I meant.

"Oh," he said. "Never had one. Harry has worked here for 47 years—knows where everything's at. He's the building custodian. That's the guy you want."

"Where is Harry now?"

"Acapulco."

"I see." I scratched a temple. "Any chance of reaching him?"

"...We could page him," the sergeant offered.

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Circle (40) on Fast Fact Card

He appeared puzzled when I told him I doubted that Acapulco was in pager range.

"Well I'll be dipped!" he exclaimed. "Next you're going to tell me that my car phone doesn't pick up its signal from nearby telephone lines!"

"I'll save that for another day," I said.

We made our way to the basement, shining our lights for signs of radio life as we went.

I picked up a coax bundle and followed it to a locked door. "Key," I said with my hand outstretched.

"Harry's got 'em," the sergeant responded. "Keeps them tied to a belt loop with aircraft cable. Harry's never lost them keys in 47 years."

I made it through the door with a 12-inch slotted by 3 a.m. Inside was an assortment of unlabeled equipment. The main police base was finally determined to be a unit made by Zlxton, or something equally Greek. I searched the cabinet and surrounding area. No manuals. The sergeant shrugged.

"Get outta town," he quipped. "You mean you need a book to fix this stuff?"

I ended up rigging a battery charger to a car battery (in a ventilated area) and then to a spare mobile radio we

the use of system diagrams. It may take a little extra time to draw one up either at installation or during the first non-emergency trip to a new customer—but the benefits of having one in a single oh-dark-thirty service call will far outweigh this.

A system diagram is a block-diagram drawing of a customer's fixed equipment. It generally is used only for customers with a wide array of equipment or numerous fixed sites or both. Rudimentary road maps and building floor plans may also be inserted into a system diagram. Typical entries include:

- equipment model and serial numbers.
- channel numbers and frequencies.
- customer's individualized unit designations.
- radio-tie line numbers.
- building numbers, room numbers, street addresses.
- customer contact names and phone numbers.
- door key locations and special access instructions.
- lists and locations of manuals and spare equipment.
- tone, dc or local classifications.
- emergency procedures.

stumbled upon. A 20-foot jumper of RG-8 allowed the use of the rooftop antenna, and allowed the dispatcher to sit behind his grid-and-dispo board in the comm center.

The appropriate contracted technician could sort things out in the morning. I didn't want to steal all his fun.

The point of the story is to promote

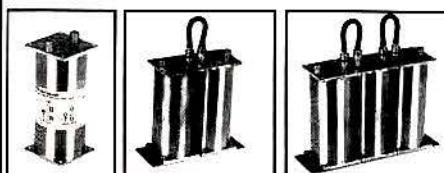
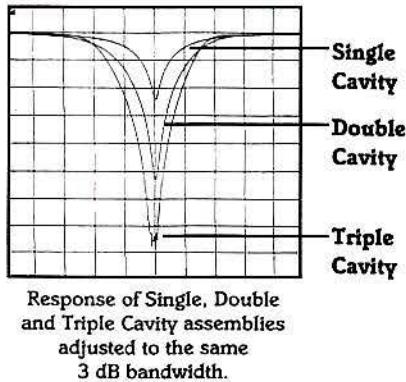
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50 - 108 MHz  
108 - 216 MHz  
216 - 450 MHz  
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The method I have found to work best is to equip each field technician with a book of all customer system diagrams, give one copy to primary customer contacts, and post a copy in a visible location near a customer's equipment.

I have used system diagrams repeatedly to isolate a "hidden" or forgotten remote that was loading down a system. System diagrams are a handy reference for quick refamiliarization of customer equipment long unseen.

And hey, they look professional. A customer having hard evidence that the shop looking out for his equipment is well organized won't be so eager to switch to another, and won't be so reluctant to mail in that monthly maintenance fee. It all works together.

On the way out I informed the sergeant that the front door to the station house was unlocked. "Better get Harry back here," I said. "Wouldn't want him to part with those keys."



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# IWCE/Fall preshow overview

Adapting with the growing mobile industry, the International Mobile Communications Expo/Fall show is emphasizing wireless and changing its name to the International Wireless Communications Expo/Fall (IWCE). This year's show will be held at the Philadelphia Convention Center, Philadelphia, Sept. 21-23, and it includes three days full of technology-oriented exhibits and seminars.

On Tuesday morning, Sept. 21, a free opening session and continental breakfast will feature a round table discussion by key executives about the converging technologies of wireless, voice and data.

The new chairman of the Federal Communications Commission (FCC) will address the IWCE attendees on Wednesday, Sept. 22, about regulation timetables, personal communications services (PCS) allocation and licensing, and wireless communications' future.

The seminars are divided into International Wireless, Regulatory, Technology and End User tracks.

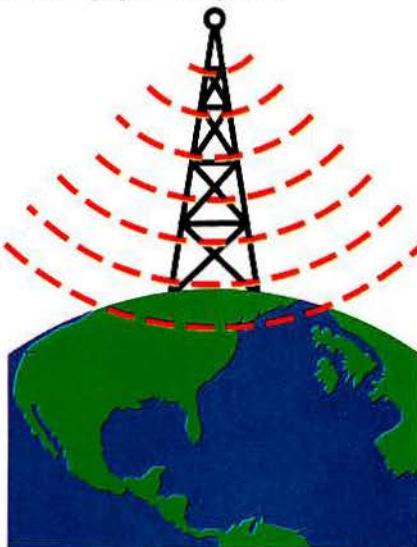
International Wireless topics include: "The North American Free Trade Agreement: An Update," "Mobile Communications Opportunities in the Americas," and updates on the Canadian and Mexican mobile communications techniques, planning and execution.

The Regulatory track includes round table discussions about the FCC and the Washington Regulatory scene and "The North American Free Trade Agreement: The Debate."

Persons attending the Technology track will learn about the opportunities for 220MHz, spread spectrum and digital SMR. Other topics include: "EMF Scare: The Truth Behind the Hype," "Test Equipment Tricks with Bruce Marcus," and "Networking the World of Wireless."

The End User track of seminars includes: "Mobile Data Equipment Update," "Mobile Data Networks," "Mo-

bile Data Applications," "Wireless Applications in Public Safety" and "Public Safety Mobile Communications Equipment Update."



More than 200 exhibiting companies will display products and services at the convention center. Mobile communications products on display include:

- ✓ mobile and portable radios
- ✓ cellular services and equipment
- ✓ mobile satellite services
- ✓ antennas
- ✓ paging equipment
- ✓ personal communications systems
- ✓ shelters
- ✓ test equipment
- ✓ tone signaling and control equipment
- ✓ towers, engineering and consulting services
- ✓ mobile data equipment
- ✓ batteries and accessory equipment.

Refer to the box below for a list of exhibit and seminar hours, as well as show information at a glance.

*Mobile Radio Technology* will be exhibiting in booth 437.



## Event: International Wireless Communications Expo/Fall

**Dates: Sept. 21-23**

**Location: Philadelphia Convention Center**

**City: Philadelphia**

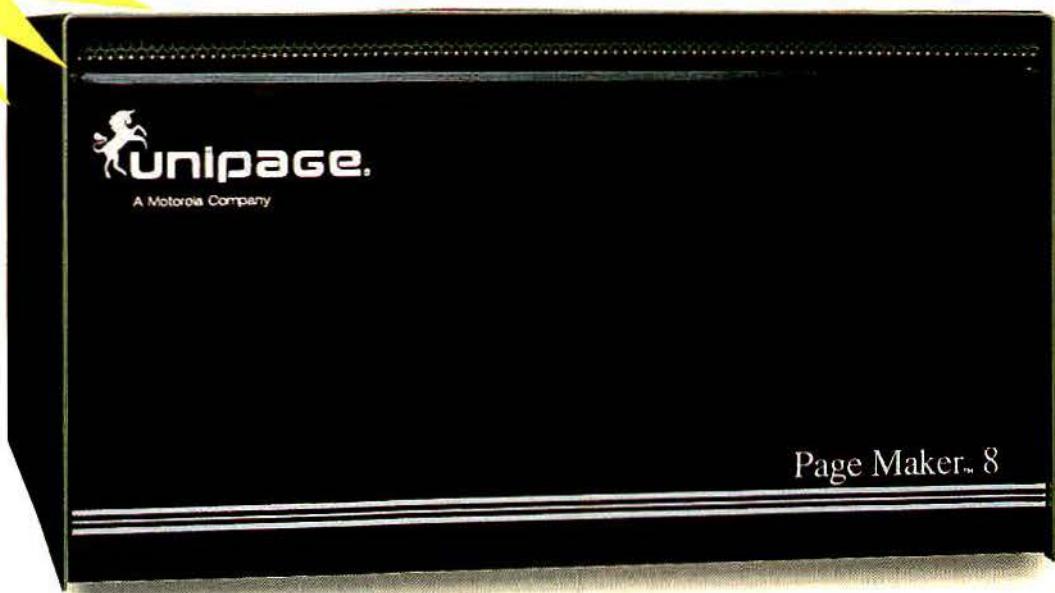
**Number of Exhibitors: 200**

**Projected Attendance: More than 4,000**

**Exhibit Hours: Tuesday, Sept. 21, 11 a.m. to 6 p.m.  
Wednesday, Sept. 22, 11 a.m. to 5 p.m.  
Thursday, Sept. 23, 10 a.m. to 1 p.m.**

**Seminar Schedule: Tuesday, Sept. 21, 9 a.m. to 4:15 p.m.  
Wednesday, Sept. 22, 9 a.m. to Noon, 2 to 4:45 p.m.  
Thursday, Sept. 23, 10 a.m. to 1 p.m.**

**Registration/Hotel Information: 303-220-0600**



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- A VP8 Card for Caller Prompting
- A Dual Trunk Card (two trunk inputs)

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# Mobile Communications Marketplace preview

Members of the paging, cellular, personal communications service (PCS) and conventional mobile telephony industries will convene Sept. 28-Oct. 1 at the Telocator-sponsored Mobile Communications Marketplace. More than 100 companies will display, demonstrate and explain their products and services, and a special section of the exhibit hall will be devoted to the display of new products.

Two simultaneous pre-convention seminars will lead off the educational side of the conference. They are on Tuesday, Sept. 28, and will inform attendees on RF exposure issues and PCS development. A special session titled "Today's Knowledge: Tomorrow's Success" will be on Wednesday, Sept. 29.

Panels, give-and-take round table discussions and the program of sessions cover a variety of topics, including paging opportunities, the secrets of selling, regulatory matters, consumer billing, the latest in PCS, how to get financing and ESMR vs. digital cellular.

John Clendenin, chairman and chief executive officer of BellSouth, will give the "State of the Industry" keynote address on Wednesday, Sept. 29.

**Event: Mobile Communications Marketplace**

**Dates: Sept. 28-Oct. 1**

**Location: New Orleans Convention Center**

**City: New Orleans**

**Number of Exhibitors: More than 100**

**Exhibit Hours: Wednesday, Sept. 29—noon to 5 p.m.**

**Thursday, Sept. 30—noon to 5 p.m.**

**Friday, Oct. 1—8 a.m. to noon**

**Seminar Schedule: Tuesday, Sept. 28—8 a.m. to 5 p.m.**

**Wednesday, Sept. 29—9 a.m. to noon**

**Thursday, Sept. 30—8 a.m. to noon**

**Friday, Oct. 1—8 a.m. to noon**

**Registration/Hotel Information: 202-467-4770**

Several special events are scheduled during the conference. The opening reception is on Wednesday, Sept. 29 from 5:30-7:30 p.m. The Chairman's dinner is at the New Orleans Hilton Riverside on Tuesday, Sept. 28 at 6:30 p.m. The dinner will honor current and past recipients of Telocator's Industry Awards and will commemorate the 10th anniversary of LifePage, Telocator's community service program.

For a complete rundown on sessions, dates and times, refer to the "Sessions" guide below and on page 54.

Copies of *MRT* may be found on exhibit in booths 845 and 847. Stop by and pick up a copy and sign up for a free subscription.

## Sessions

| DAY                    | TIME           | TOPIC  |
|------------------------|----------------|--|
| Tuesday,<br>Sept. 28   | 8 a.m.-5 p.m.  | <i>Pre-Convention Seminars</i><br><i>Seminar I: RF Exposure Issues</i><br><i>Seminar II: PCS Development</i> |
|                        | 6:30 p.m.      | Awards Reception and Dinner  |
| Wednesday,<br>Sept. 29 | 9-10:30 a.m.   | Opening General Session  |
|                        | 10:45 a.m.     | <i>Special Session: Today's Knowledge: Tomorrow's Success</i>  |
|                        | noon           | Exhibits Grand Opening   |
|                        | 5:30-7:30 p.m. | Opening Reception  |



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## Mobile Communications Marketplace

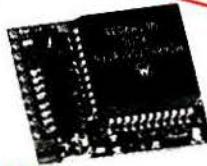
| DAY                   | TIME            | TOPIC  |
|-----------------------|-----------------|--|
| Thursday,<br>Sept. 30 | 8-9 a.m.        | <i>Early-bird Sessions</i><br>Tax Policies in the Clinton Era: What They Mean To You<br>Compliance From "A" To "Z"<br>Secrets of Selling<br>Alpha Paging Opportunities<br>Billions of Beepers: Red, White and Blue<br>PCS Service Descriptions                                 |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       | 9-10:30 a.m.    | <i>Concurrent Session I</i><br>Moving From Customer Service To Customer Care<br>Trends of the 1990s: Consolidation<br>Latest News on PCS Technology<br>Cutting a Deal for Spectrum With Broadcasters: A Desirable Option<br>Promoting Positive Images of Mobile Communications |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
| Friday,<br>Oct. 1     | 10:45 a.m.-noon | <i>Concurrent Session II</i><br>FCC Issues and Answers<br>Trends of the 1990s: Diversification<br>Innovations in Retail Paging<br>Advanced Messaging Update<br>Changing Ideas About Consumer Billing<br>The PCS Link Between Computers and Communications                      |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       | 8-9 a.m.        | <i>Concurrent Session III</i><br>Advanced Media Relations: Maximizing Media Coverage<br>ESMR vs. Digital Cellular<br>Making Effective Advertising Decisions<br>International Issues and Standards for PCS<br>The Power of Strategic Planning in Your Success                   |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       | 9-10:30 a.m.    | <i>Concurrent Session IV</i><br>Selling To New Market Segments<br>How To Deal With Difficult People<br>How To Get Financing<br>The "New" Rules Part 22<br>PCS Gurus Predict Its Performance  |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       |                 |  |
|                       | 10:45 a.m.-noon | <i>Concurrent Session V</i><br>Productivity = People Power<br>How Paging Can Profit from the Wireless Data Revolution<br>Educating the Financial Community<br>Update: FCC Report and Order on PCS  |
|                       |                 |  |
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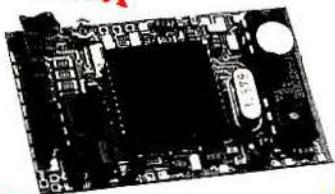
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- ◆ Ten number memory dial, last number redial
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## Technically speaking

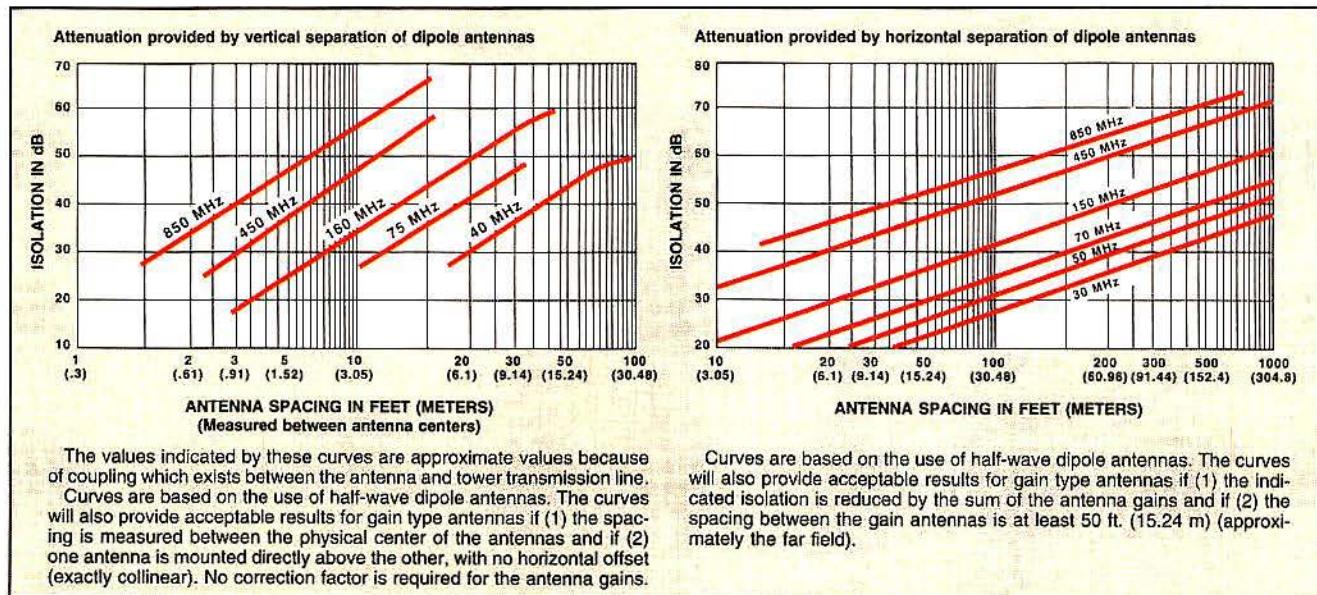


Figure 2. These graphs can be used to approximate the amount of isolation provided by vertical (left) or horizontal (right) separation of antennas. (Courtesy of Decibel Products.)

(continued from page 8)

loss and any filter losses must be taken into account to calculate the receiver

input signal level. Let's say the line loss is 2dB and no filters are used.

► *Calculating the noise signal level:*  
Now we have enough information to

arrive at a fairly good approximation of the level of the transmitter noise component (on the receiver frequency) at the receiver's input. (See Figure 3

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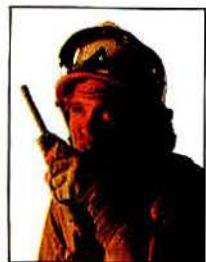
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# Have all those 2-Way Radio promises gone up in smoke?



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The **TK-630, 730, 830 Series mobiles** can be customized for many applications, including dual band and dual head configurations. And unlike other radios requiring expensive add-ons, the TK-630, 730, 830 Series come with these standard features:

- Built-in Public Address
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- Speaker Control
- Talk Around
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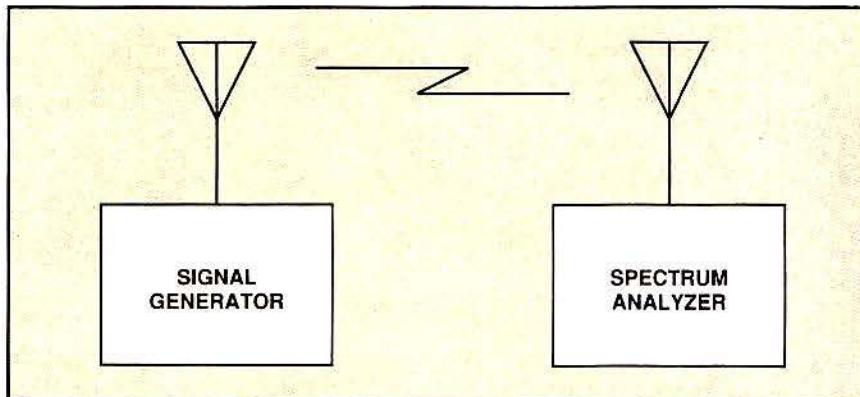


Figure 5. This simple setup can be used to determine existing isolation between two antennas with better precision than the graphs might provide. Feed a 0dBm signal into one antenna and measure the dBm level at the other antenna with a spectrum analyzer. The spectrum analyzer display level equals the isolation between the two points. If the spectrum analyzer display is at the -50dBm level, then the isolation is 50dB.

model transmitter with reduced sideband noise level. The manufacturer's graph of transmitter noise vs. frequency shows that, at a frequency 225kHz removed from the carrier, the noise level is down -102dBc (dB below carrier). This level represents a considerable improvement compared

to the -63dBc noise component level used in the example for Figure 1A.

Another improvement results from mounting antennas with vertical, rather than horizontal, separation. Notice from Figure 2A (160MHz) that the antenna isolation is approximately 50dB for 20 feet of vertical separation.

Furthermore, it is not necessary to deduct the sum of the antenna gains from the isolation figure on the graph as it was for horizontal separation. This difference alone gives an additional 12dB of isolation.

Now let's recalculate the level of the offending transmitter noise component. (See Figure 4 on page 58.)

With the different antenna arrangement and the higher-quality transmitter, the offending transmitter noise component has been reduced to -106dBm, only 20dB above the required level. The remaining 20dB of attenuation can be obtained with a single notch cavity on the transmitter tuned to 159.120MHz.

### ► Measuring antenna isolation:

If the antennas are already installed you can measure the exact isolation between the two antennas by using the equipment setup shown in Figure 5.

First, set the signal generator to 0dBm and, with the generator connected directly to the spectrum analyzer, make sure the spectrum analyzer

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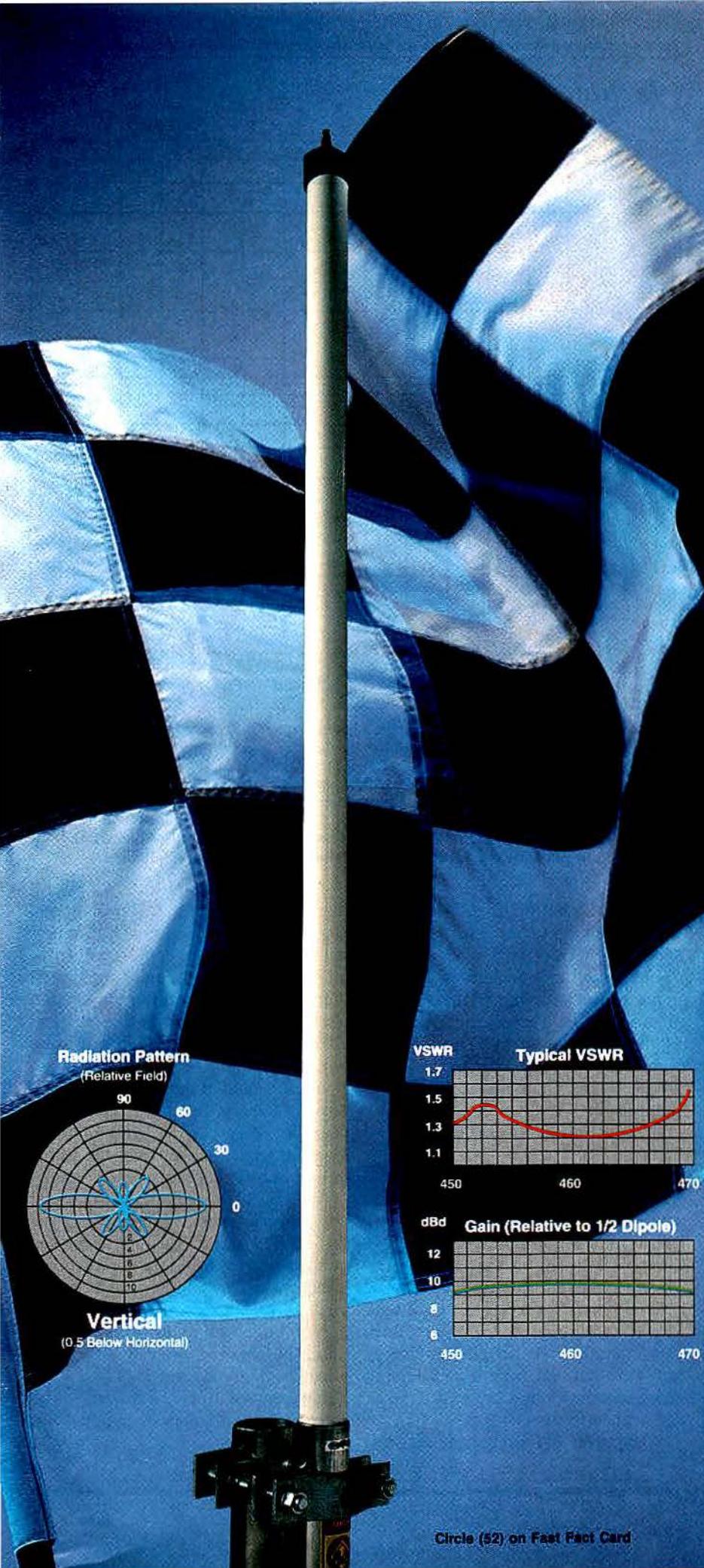
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City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

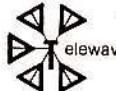
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## Technically speaking

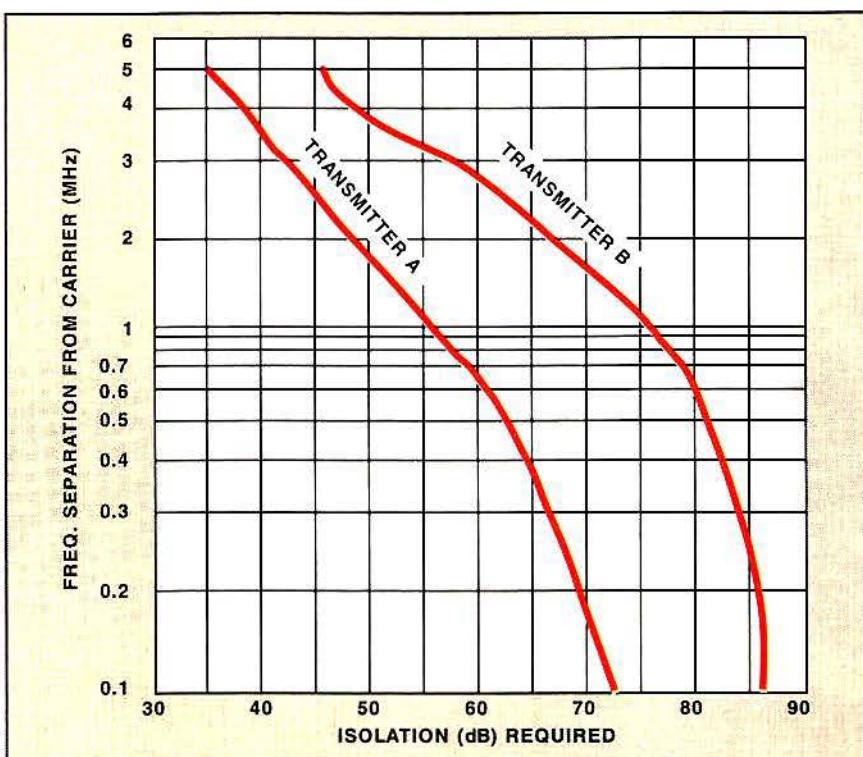


Figure 6: This graph shows that all transmitters are not created equal. It indicates the amount of isolation required between the transmitter (operating at 100W or +50dBm) and the receiver (with a sensitivity of  $0.35\mu\text{V}$  at 12dB SINAD). Notice that transmitter A requires much less isolation to prevent interference to the desired receiver signal than does transmitter B. This is because transmitter A produces less sideband noise than transmitter B, that is, transmitter A is cleaner. Remember, the required isolation indicated by the graph is the entire attenuation between the transmitter output and the receiver input—line losses, filter losses, isolator loss and antenna isolation.

display reads 0dBm. Then connect the signal generator to one antenna and the spectrum analyzer to the other antenna.

Feed a 0dBm signal from the generator to the antenna and measure the signal level on the spectrum analyzer at the other antenna. This step is simple if the transmitter and receiver are in the same building (antennas on same tower).

### ► Transmitter isolation requirements:

The graph in Figure 6 above illustrates the difference between the transmitter sideband noise suppression of two different transmitters. These two curves are based on the isolation required to prevent sideband noise from interfering with a receiver with a sensitivity rating of  $0.35\mu\text{V}$  at 12dB SINAD. These curves are not imaginary, but were derived from actual equipment specifications from two popular radio manufacturers.

To compare the two transmitters, the

curve for transmitter A shows that, at 200kHz spacing between transmitter and receiver frequencies, approximately 69dB of isolation is required between the transmitter output and receiver input. For transmitter B at 200kHz, approximately 85dB of isolation is required.

These isolation figures includes line losses, antenna isolation, filter losses and any other passive loss—in short, every attenuation between the transmitter output and the receiver input.

When selecting equipment for use at high-density sites, compare the specifications carefully. Be sure to ask the manufacturer for data on receiver desense and transmitter noise before making a decision.

You might get a lower price on the initial purchase of lower-quality equipment, but you may end up paying more for expensive filters. The net difference in green might put you in the red.

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Circle (54) on Fast Fact Card

## Mtel receives first FCC Pioneer's Preference

The FCC has granted Mobile Telecommunications Technologies (Mtel) the first final Pioneer's Preference for a two-way personal communications system (PCS) in the United States. The FCC has allocated 11 channels for nationwide PCS use and has assigned one of these to Mtel, which plans to file a formal license application for authority to construct the system as

soon as permitted by FCC rules.

The FCC decision assigns 50kHz of radio spectrum in the 930MHz band for Mtel to build a two-way wireless network called Nationwide Wireless Network (NWN). The system will allow people to send and receive wireless messages using laptops, palmtops and hand-held messaging units called personal digital assistants (PDAs),

which are being developed by the computer industry. NWN will also use acknowledgement messengers or pocket-size devices capable of returning confirmations of message receipt to senders.

Upon final licensing, NWN will operate in at least the top 300 U.S. markets by 1995. It is a location-independent system, meaning that messages can be sent and received without the need to know the city in which the other party is located. The network will consist of more than 3,000 base station receivers and transmitters, blanketing metropolitan areas and eliminating the need for users to notify the network with roaming instructions.

## MobileComm tests high speed paging protocol

MobileComm, Jackson, MS, will begin testing the new Flex high speed paging protocol technology from Motorola, Schaumburg, IL. The technology will allow numeric and alphanumeric messages and data transference to be sent at 6,400 bps.

The technology will increase the number of users per radio frequency, improve battery life in wireless devices and help expand wireless service offerings such as electronic mail; information services; the updating of personal calendars to pagers; and personal organizers, portable computers or personal digital assistants (PDAs).

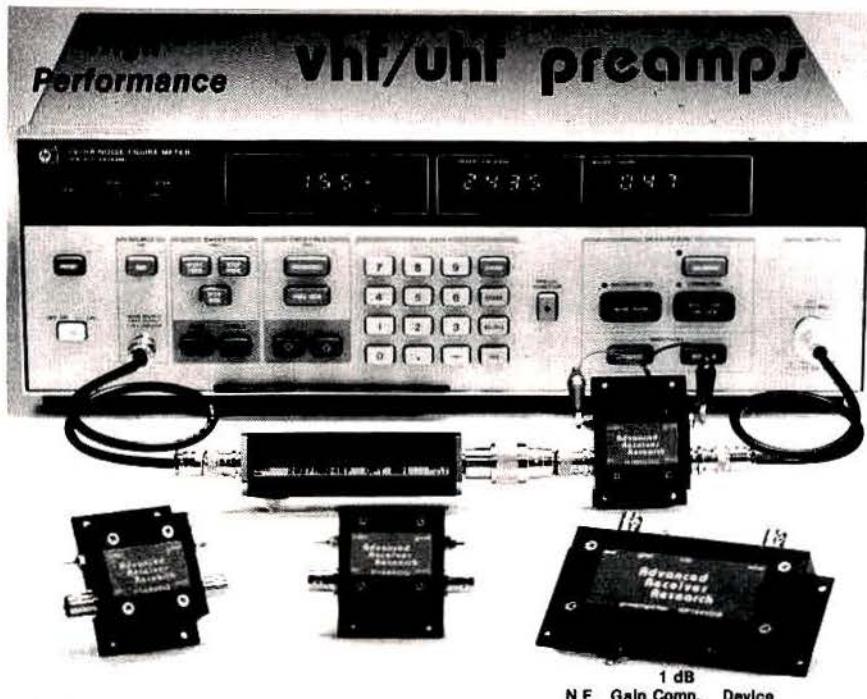
## Ram Mobile Data completes phase I of network expansion

Ram Mobile Data, New York, has installed the 840th and final base station in its phase I network buildout, fulfilling its pledge to provide wireless data service to more than 90% of the nation's urban business population by the end of June 1993.

The two-way shared wireless data service infrastructure was built from the ground up. Ram's networks provide coverage to more than 6,000 cities in 210 metropolitan areas in the United States, compared to 50 metropolitan areas a year ago.

## Hark's board comes out on top in field tests

Field tests conducted by Hark Systems, Summerville, SC, and Motorola, Schaumburg, IL, show an improvement in audio quality when the standard TRIB board was replaced by the Hark TRAC board, which was developed specifically for Motorola to enhance the audio quality when using the standard centralized interconnect. When the standard board was replaced, data and fax transmission occurred at a higher baud rate with fewer errors.



|                                    | Freq. Ranges (MHz)         | N.F.<br>(dB) | Gain<br>(dB) | Comp.<br>(dBm) | Device<br>Type | Price     |
|------------------------------------|----------------------------|--------------|--------------|----------------|----------------|-----------|
| Receive only                       | 30-35, 35-40, 40-45, 45-50 | <1.3         | 15           | 0              | DGFET          | \$ 44.95  |
| P30VD, P35VD, P40VD, P45VD         | 30-35, 35-40, 40-45, 45-50 | <0.5         | 26           | +12            | GaAsFET        | \$ 109.95 |
| P30VDG, P35VDG, P40VDG, P45VDG     | 30-35, 35-40, 40-45, 45-50 | <0.5         | 26           | +12            | GaAsFET        | \$ 109.95 |
| P150VD, P180VD, P170VD             | 150-160, 160-170, 170-180  | <1.5         | 15           | 0              | DGFET          | \$ 44.95  |
| P150VDA, P180VDA, P170VDA          | 150-160, 160-170, 170-180  | <1.1         | 15           | 0              | DGFET          | \$ 56.95  |
| P150VDG, P180VDG, P170VDG          | 150-160, 160-170, 170-180  | <0.5         | 24           | +12            | GaAsFET        | \$ 109.95 |
| P450VD, P460VD                     | 450-460, 460-470           | <1.8         | 15           | -20            | Bipolar        | \$ 49.95  |
| P450VDA, P480VDA                   | 450-460, 460-470           | <1.2         | 16           | -20            | Bipolar        | \$ 74.95  |
| P450VDG, P460VDG                   | 450-460, 460-470           | <0.5         | 16           | +12            | GaAsFET        | \$ 109.95 |
| P800VDG, P830VDG, P860VDG          | 800-830, 830-860, 860-890  | <0.6         | 19           | +12            | GaAsFET        | \$ 119.95 |
| Inline (rf switched)               |                            |              |              | 1 dB           |                |           |
| SP30VD, SP35VD, SP40VD, SP45VD     | 30-35, 35-40, 40-45, 45-50 | <1.4         | 15           | 0              | DGFET          | \$ 74.95  |
| SP30VDG, SP35VDG, SP40VDG, SP45VDG | 30-35, 35-40, 40-45, 45-50 | <0.55        | 26           | +12            | GaAsFET        | \$ 139.95 |
| SP150VD, SP160VD, SP170VD          | 150-160, 160-170, 170-180  | <1.8         | 15           | 0              | DGFET          | \$ 74.95  |
| SP150VDA, SP160VDA, SP170VDA       | 150-160, 160-170, 170-180  | <1.2         | 15           | 0              | DGFET          | \$ 86.95  |
| SP150VDG, SP160VDG, SP170VDG       | 150-160, 160-170, 170-180  | <0.55        | 24           | +12            | GaAsFET        | \$ 139.95 |
| SP450VD, SP460VD                   | 450-460, 460-470           | <1.9         | 15           | -20            | Bipolar        | \$ 79.95  |
| SP450VDA, SP460VDA                 | 450-460, 460-470           | <1.3         | 16           | -20            | Bipolar        | \$ 104.95 |
| SP450VDG, SP460VDG                 | 450-460, 460-470           | <0.55        | 16           | +12            | GaAsFET        | \$ 139.95 |

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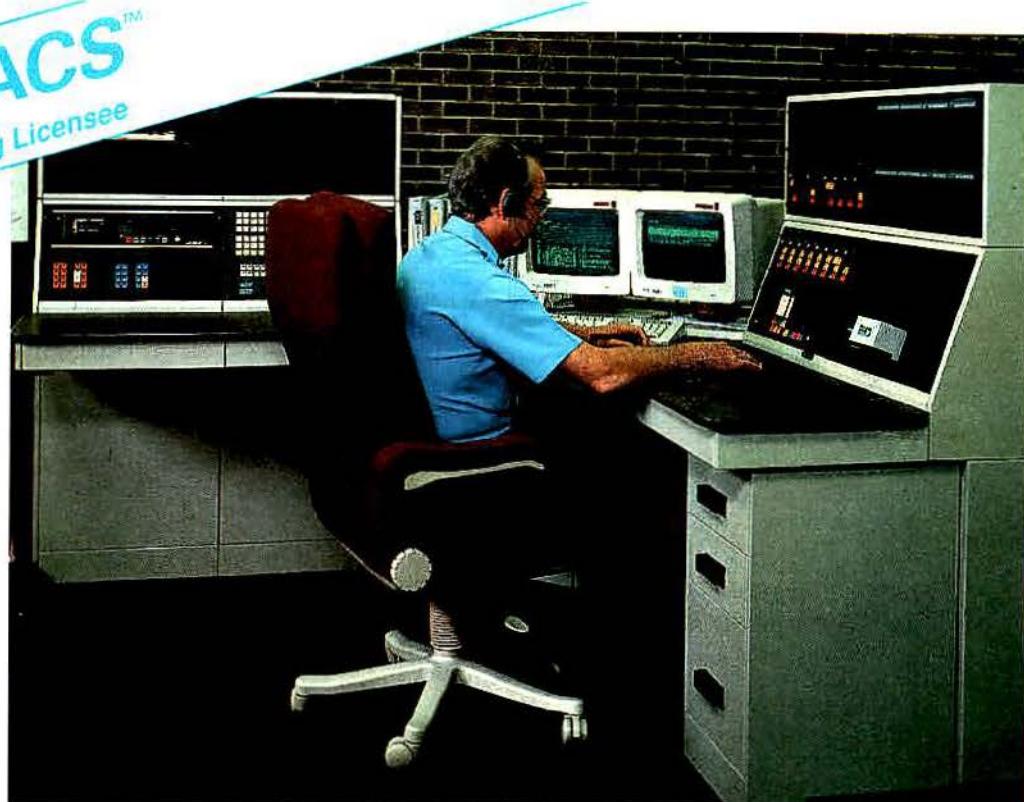
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 **ORBACOM**  
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## News

### New Hampshire police, Motorola install digital FM two-way system

The New Hampshire state police and Motorola, Schaumburg, IL, have installed Phase Two of the first public safety digital narrowband FM two-way communication system. The system includes 100 Motorola Astro mobile and portable radios, Centracom series II Plus consoles and a four-site voting system.

Phase Two provides coverage in two counties in the southeast portion of the state, but the long-range plan is to convert

the statewide communication system to the digital capability. The system will accommodate the public safety digital communications standards, known as Project 25, established by the Associated Public-Safety Communications Officers (APCO). The standard will include provisions for a common air interface (CAI), trunking, encryption, data and inter-system signaling; although, only the CAI portion has been finalized.

### IBM selects Dataradio as business partner for public safety market

Dataradio, Atlanta, has been selected by IBM, Tulsa, OK, to provide mobile data systems to the public safety market. The IBM Business Partner program has been in existence for more than 10 years and provides the company with selected application software and hardware offerings that provide system solutions for customers.

IBM chose Dataradio and its Vehicular Information Series (VIS) product line after completing a comprehensive study of available technology.

### Legge, other investors acquire CES

The assets, operations and future business of Communications Electronics Specialties, Winter Park, FL, have been acquired by CES Acquisition. CES Acquisition is owned by eight individual investors led by CES president Richard C. Legge Jr., who owns a controlling interest in CES Acquisition.

Legge joined CES in 1985 and was promoted to president in 1988. He is chairman and president of the new company.

CES will continue to operate from its Winter Park facility.

### First commercial 220MHz radio system placed in operation

The first commercial, five-channel trunked 220MHz radio system is operating in Houston. The system is equipped with mobile and repeater products from SEA, Mountlake Terrace, WA, and will be managed by Repeater Communications.

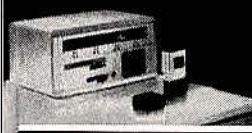
The Houston system is the first of several 220MHz trunked radio systems planned for construction and operation by NNC, a consortium of 220MHz license holders, select SMR operators, private investors and SEA. Among the cities where other NNC 220MHz systems will be constructed are San Francisco, Dallas, Chicago, New York, Atlanta, Denver and Los Angeles.

### Glenayre licensed to provide high speed protocol

Glenayre, Duluth, GA, has been licensed by Motorola, Schaumburg, IL, to manufacture equipment compatible with Motorola's new Flex high speed paging protocol. Glenayre plans to incorporate the technology into new and existing products in 1993.

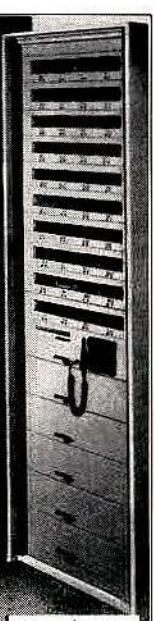
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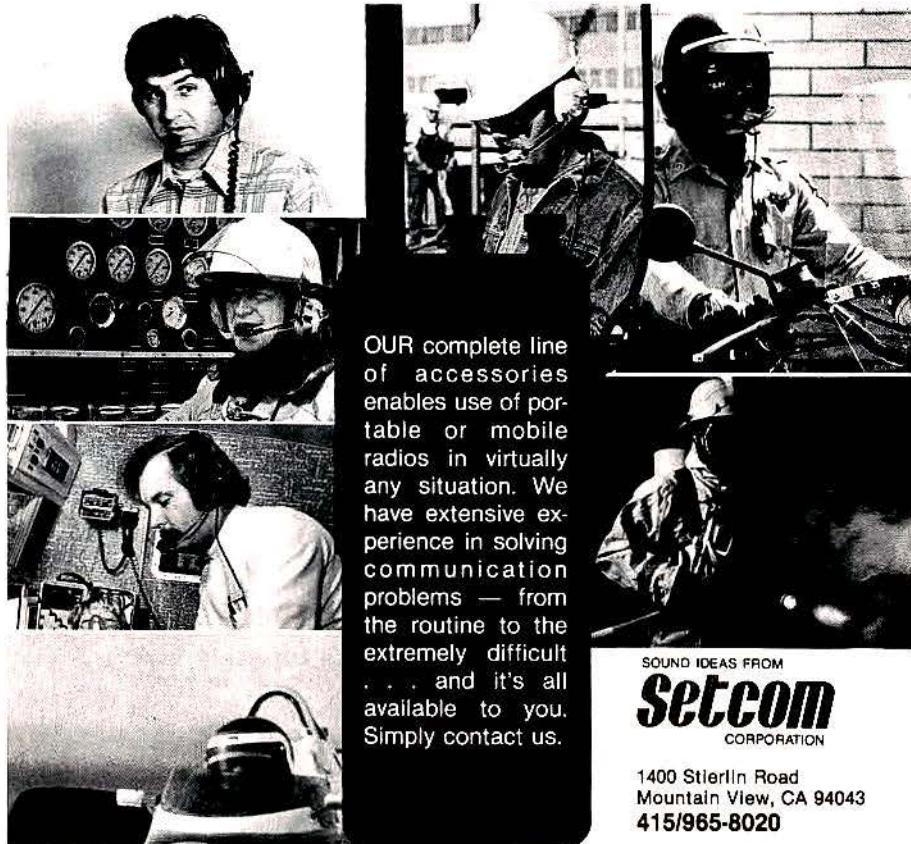
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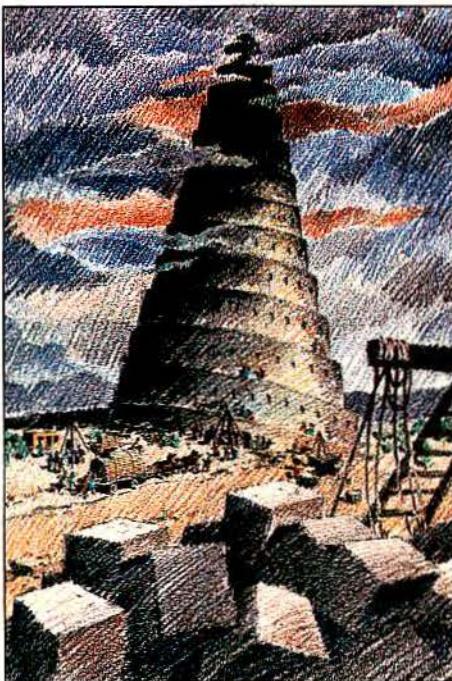
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## Lesson No. 1: Follow the money

By Robert H. Schwaninger Jr.

I've been writing this column for about six months, and it occurred to me that I haven't provided you with my handy-dandy, never-fail method of tracking regulation.

With a few simple tips, you too can start to find the path of logic that winds mysteriously among the jungle of special and government interests. It all starts with Lesson No. 1: Follow The Money.

Grab your pith helmet and butterfly net, and follow me! Mind you, it isn't always easy. Sometimes the wilder (and richer) animals can eat you alive when you are on a special interest safari, especially if your business is the bait. But maybe if you are able to analyze what's going on, you will be less vulnerable to attack.

Let's start with a simple case.

A two-way dealer gets a chance at a new customer who wants to buy 25 new radios to operate on a pretty clean frequency. The first thing the dealer is going to do is to sell the radios with the best performance and the biggest profit margin. See? Simple. The transaction all makes sense if you *follow the money*.

### Frequency coordination

The dealer calls NABER\* to find a fre-

quency and is recommended one that is fairly good, so the dealer decides to license it in his name rather than the customer's name. The dealer figures he might be able to load a few more users onto it. The dealer is acting in his economic self-interest when he gets a *private carrier* license.

frequency because it is a certified frequency coordinator. The FCC, the federal agency that used to coordinate frequencies for free and lost its shirt doing it, certified NABER, among others, to do the job on a more-or-less exclusive basis.

That way the coordinators could make a dollar and the FCC wouldn't have to spend any more money doing pedestrian things such as frequency coordination. Its time would be better spent deciding such issues as whether rats can get cancer from RF energy emitted by electrical lighting dimmer switches.

The frequency coordination system saved the FCC a bundle. Thousands of hours that previously were devoted to co-ordinating frequencies were made available to unsnarl the point-to-point microwave applications, to process lottery applications from the application mills and to write speeches to Congress about spectrum auctions—another money-maker.

### *The question is, how can Congress make megabucks out of megahertz and not rock the re-election boat?*

NABER is acting in its self-interest when it charges the dealer a premium for private carrier status. This value-added transaction makes sense if you *follow the money*.

NABER is able to recommend that fre-

\*NABER is the National Association of Business and Educational Radio, an Arlington, VA-based trade association that coordinates frequencies for the Business Radio Service.

### Free labor—dealer pays

The best part of it is that the FCC gets all this free labor from the frequency coordinators and the dealer pays for it. This arrangement explains why the FCC has been one of the frequency coordination system's biggest fans, if you remember Lesson No. 1.

When the FCC found that there was some slack left after farming out the frequency coordination duties, the question arose regarding what to do with this available, albeit limited, manpower.

The agency could have stepped up its efforts in enforcement, but there's no money in that. The fines are too low, the cost is too high and the forfeitures just get dumped into the U.S. Treasury. Besides, every time the FCC levies a really big fine, it's against a really big company with really noisy lobbyists on Capitol Hill.

### Where Congress comes in

That brings us to Congress.

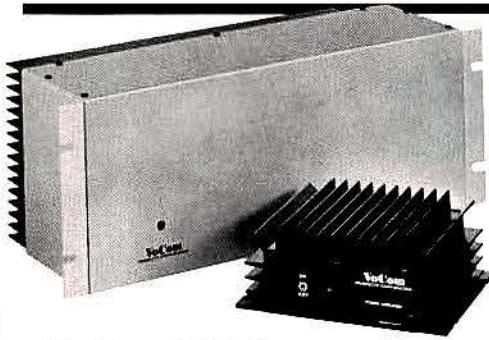
Congress has decided that the FCC can make money. It's got something that everyone wants: radio spectrum. The question is, how can Congress make megabucks out of megahertz and not rock the re-election boat?

Simple.

First, install filing fees. They look somewhat neutral, and they don't cost anyone too much.

Schwaninger, *MRT's* regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC.

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## Regulating technology

Second, increase the level of fines. If the FCC isn't going to enforce its rules very often, it might as well make a good return when it does.

Third, talk about user fees. Again, it sounds neutral, and most licensees would go along.

Finally, start the ball rolling on spectrum auctions, the alluring mother lode of payouts for the federal government that might result in gazillions of dollars pouring into the U.S. Treasury.

### Problems

Wait.

There's a problem.

If Congress auctions spectrum for broadcasting, the broadcast media will bury them alive in bad press. That could affect campaign contributions.

Okay, give broadcasters an exemption based on say, the First Amendment. Sounds noble, although no one really knows what the heck Freedom of the Press and Freedom of Speech has to do with the entire discussion. But, no matter. Sounds good, particularly to the broadcasters.

Wait.

There's another problem.

Local politicians are the ones who rally the Elks and the Optimists and the Ladies Auxiliary to throw those campaign bashes that mean money and votes for members of Congress. Better give local governments a break, too.

All right. The stage is set for auction authority. Now all Congress needs is a little spectrum to sell and the lucre can start rolling in. So, where do they look?

### Federal government spectrum

How about all those megahertz being used by the federal government for who-knows-what, and they aren't telling (national security, you know). Actually, they probably do tell Congress, but the information is contained in one of those thick, multi-volume reports sent over by the NTIA\*\*, and Congressmen haven't the time to wade through it.

The important thing is that no one will ever sit down and figure out how much the spectrum will cost the federal government in lost resources. Instead, the only number

\*\*NTIA is the National Telecommunications and Information Administration, a federal agency that administers radio spectrum allocated for federal government use.

that will be bantered about will be how much money the auctions might make.

There's only one little hitch in the scheme.

Congress doesn't want this to look like a giveaway to the largest operators. They have to do something, create some legislation, that will enable the small or minority operator to participate in the lottery.

But if they do that, Congress might reduce the amount of money to be made on the auctions. They might also be forced to wait for their money as smaller entities pay over time. And where do they draw the line between small operators and big ones? In short, they're stuck.

### Passing the buck

But Congress is never really stuck. They will simply pass a bill that speaks in terms of preserving the rights of small and minority operators and leave it up to the FCC to figure out how the system might work. The FCC will be stuck.

That is, unless the FCC creates some independent, certified group to solve the problem for them by creating industry consensus through panel discussions, round table meetings and membership seminars. In sum, the FCC might create something like a frequency coordinator to organize the business of auctioning spectrum.

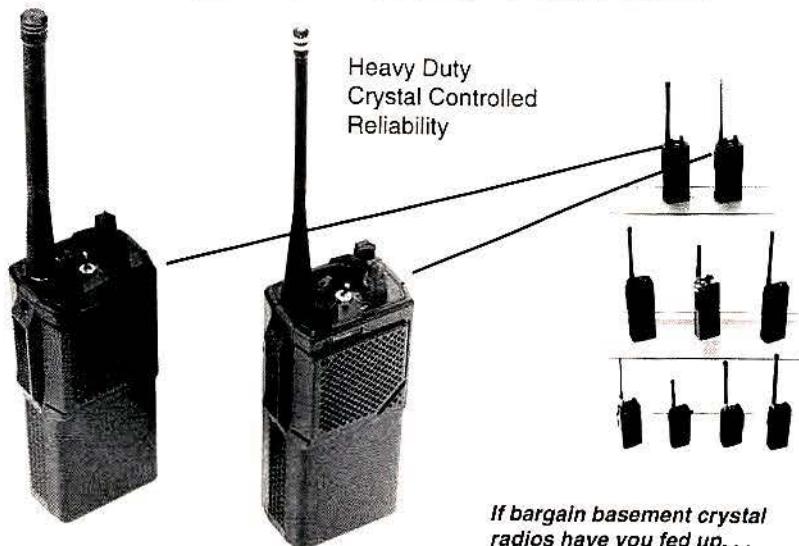
The new auction coordinator will start out with high-sounding ideals and goals, but will eventually succumb to self-interest. It won't be the auction coordinator's fault. It's just the nature of business, even the allegedly not-for-profit business.

When self-interest takes over, the auction coordinator maximizes its resources by ensuring that the entities best able to pay for dues and services wind up with the best deal. This means that, eventually, the small two-way radio dealer will pay for it.

Mind you, most of the foregoing description is merely speculative. It might happen this way (some of it already has), and it might not.

This discussion is only a hypothetical lesson in tracking regulation. We just applied Lesson No. 1: Follow The Money. We also got a good look at Lesson #2: Pass The Buck.

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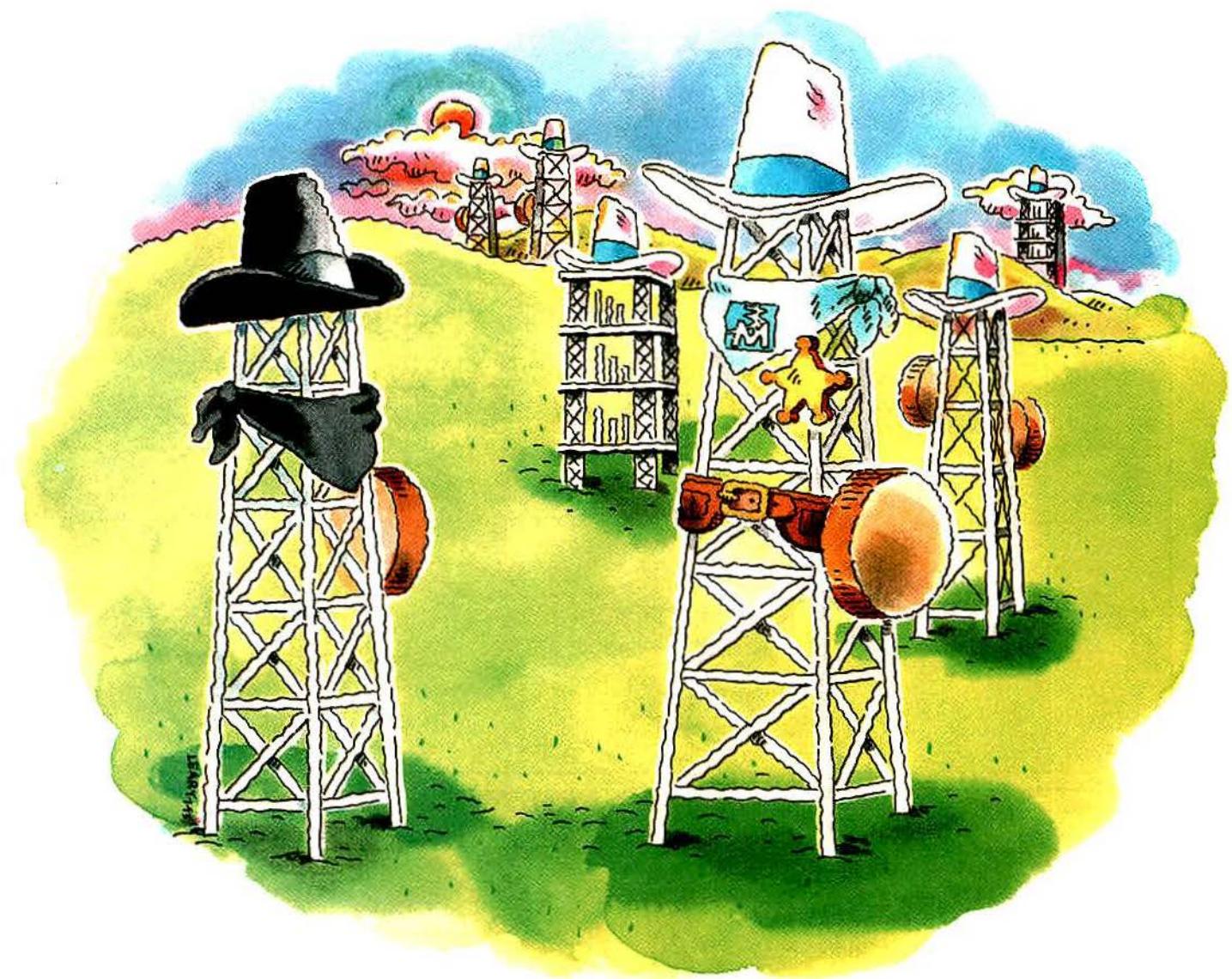
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Circle (63) on Fast Fact Card

## Readers' choice

Of all the new products and services in the February issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

### Mobile data starter kits work with many radio models

Dataradio starter kits allow mobile radio users, SMR system operators, system integrators and software developers to gain experience with mobile data at a minimum expense and with the flexibility of using a wide range of radios. The kit comes with step-by-step instructions to set up a simple mobile radio network. The VIS24 starter kit works with the E. F. Johnson 8605 and 8600 series, as well as with any conventional two-way

radio system, with or without repeaters. The VIS24 kit includes one 24F3MRM mobile radio modem, one BDLC-1 single port base station datalink controller, DRSETUP configuration software, an MTA modem test adapter for modem and radio alignment, radio interface cables and a documentation package. The VIS system also provides for an "open architecture" system design.

Circle (500) on Fast Fact Card

Phone patch offers  
DSP voice recognition



The RTU-250 uses an adaptive hybrid to convert the four-wire audio from the transmitter and receiver to two-wire audio for the phone line. It automatically matches any phone line at all voice frequencies simultaneously to provide a broadband null with no oscillation in full duplex systems. Set-up is simple with the phone patch from **JPS Communications**; neither the VOX nor the adaptive hybrid require any adjustments.

Circle (501) on Fast Fact Card

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# MORE or LESS



***PolyPhaser's Bulkhead System***

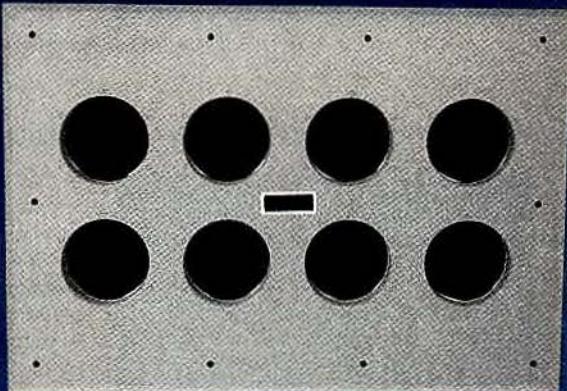
Compare PolyPhaser's Bulkhead coax cable entry system to the standard entry panel and the logical choice based on features, function and price is the Bulkhead System. 3,5,8,10,16 & 24 ports stocked. UPS shipable.

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## New products

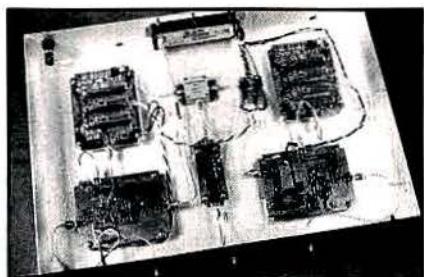
### Dual directional coupler operates between 200MHz to 6GHz



Circle (400) on Fast Fact Card

The DDC-HP-201-602-1-30 ultra-broadband dual directional coupler from **RF Power Components** operates in 200MHz-6GHz frequency bands. Measuring 5.5" x 1.6" x 1.05", the coupler is ideal in power monitoring and power sampling applications and operates with CW power of 500W from 200MHz-1GHz, 250W from 1GHz-4GHz and 100W from 4GHz-6GHz.

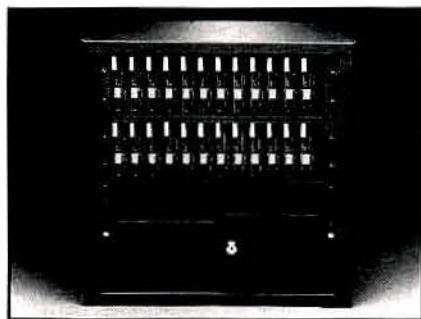
### Frequency converter covers bands from 10MHz-1,000MHz



The FTA-400 full-duplex frequency converter connects modulation-compatible, but frequency-incompatible, wireless systems with each other. The FTA-400 is inserted at any appropriate point between the RF transceiver and modem. It can accept two frequency inputs (transmit/receive) and convert to any two other frequency outputs, as long as all are within the unit's overall frequency range. The converter from **Frequency Products** is available in 10MHz-500MHz and 500MHz-1,000MHz frequency ranges.

Circle (402) on Fast Fact Card

### Paging terminals interface with analog, digital facilities



Circle (401) on Fast Fact Card

The Prism series of paging terminals feature integrated voice messaging with custom prompts, timed alpha delivery including operator entry of recorded alpha messages, fax delivery of message logs and TNPP networking. The system from **TGA Systems** includes several TNPP network trunk concentrators and TNPP network managers that are compatible with most contemporary paging terminal systems and interfaces with both analog and digital trunk facilities.

# "Paging Bomar Crystals!"



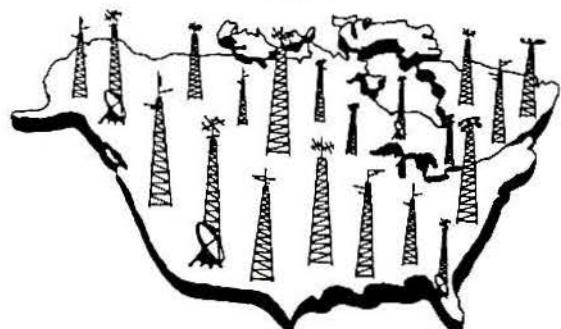
Bomar answers the call for excellence with high performance crystals designed for today's pagers. Our crystals are built to precise specs for totally clean, trouble-free reception, and won't drift .001 per cent in one year. We guarantee it. We also guarantee Bomar Crystals will outlive the pager. Check us out.

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# With the Mini-Com, what you see is less than what you get.



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- ▲ Two-Tone Sequential is built-in to the SL & PT radios. Great for Talk-Back Paging applications.
- ▲ CTCSS and DCS (standard & inverted) are built-in, too!
- ▲ Two control knobs for easy, user friendly operation.
- ▲ 6 channel capability in the SL & PT with detents

for accurate, tactile control. The SL mobiles also feature programmable beeps and bright, easy-to-read LED channel indicators.

- ▲ 16 or 99 channel capability in the SM scanning mobile radio with an easy-to-read display and very simple operation with user selectable features like scan list, priority and talk-around.
- ▲ Rugged die-cast construction and surface mount device technology for outstanding durability and performance.
- ▲ A full complement of options, including DTMF capability.
- ▲ **Now with a 2 year parts & labor warranty!**

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## New products

### Paging encoder supports TNPP protocol; encodes POCSAG, Golay



Model 61 network access paging encoder is an automatic encoder that allows

Circle (403) on Fast Fact Card

a paging transmitter to serve as a simple TNPP network node. The paging encoder from **Zetron** receives TNPP data over the network link and encodes POCSAG and Golay digital pages. It is equipped with 26 kilobytes of buffer space so pages will be efficiently queued when the paging channel is busy.

### Dc power systems come assembled, wired, tested

Dc power systems in 12V, 24V, 48V and 130V from **Ratelco** are shipped assembled, wired and tested in a variety of frameworks. Fuse and circuit breaker panels, ground bars, relay racks and other components are additional options.

Circle (404) on Fast Fact Card

### Quartz crystals measure 4.7mm to 8.00mm in height



The UM series of miniature quartz crystals cover the 10MHz-160MHz frequency range. The crystals from **Mercury United**

Electronics are distinguished by crystal holder height: the UM-1 is 8.0mm, the UM-5 measures 6.0mm and the UM-4 is 4.7mm. Calibration tolerance  $\pm 10\text{ppm}$  at  $25^\circ\text{C}$  and frequency stability  $\pm 10\text{ppm}$  between  $-10^\circ\text{C}$  to  $+60^\circ\text{C}$  is standard.

Circle (405) on Fast Fact Card

### Alphanumeric paging software allows 250-character message

Alfie-Jr. is a Microsoft Windows compatible version of **Etek's** DOS message center program for alphanumeric paging. Alfie-Jr. allows the user to enter a 250-character message and automatically send it to one or more people in the built-in database. The Tollsaver feature prevents unnecessary redialing, and a date and time stamp can be attached automatically to all messages. The program comes with a 30-day guarantee and an 800-number for product support.

Circle (406) on Fast Fact Card

### Module converts radio into trunking radiotelephone



The **RTX 7530** mobile control module converts Patriot-150 VHF and RPM-450 UHF mobiles into trunking radiotelephone, radio trunking dispatch systems or both. When the RTX 7530-enabled Patriot mobile is connected with the RTX 6000 series repeater controller, the user can make local radio dispatch calls and local, national and international telephone calls.

Circle (407) on Fast Fact Card

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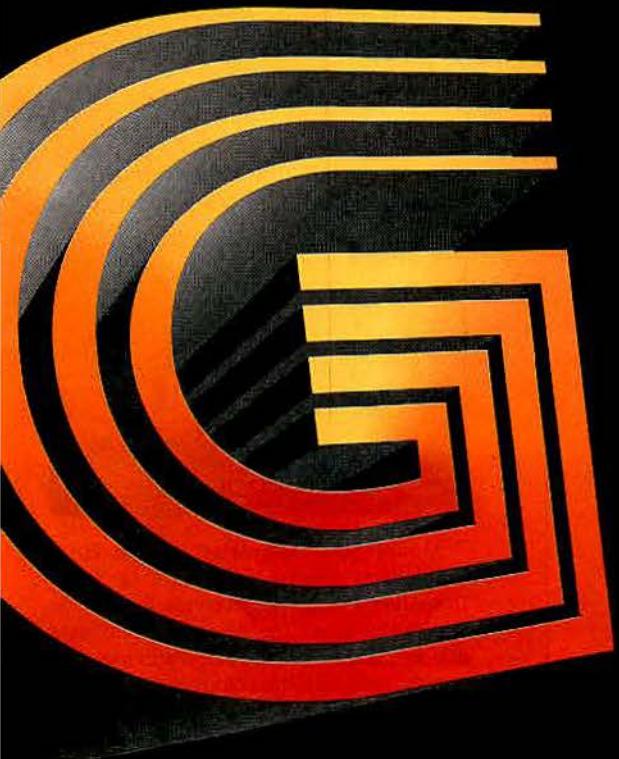
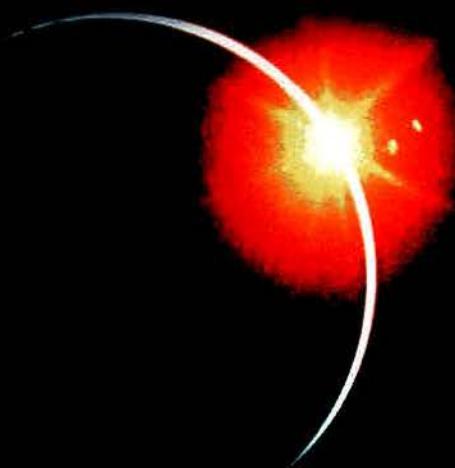
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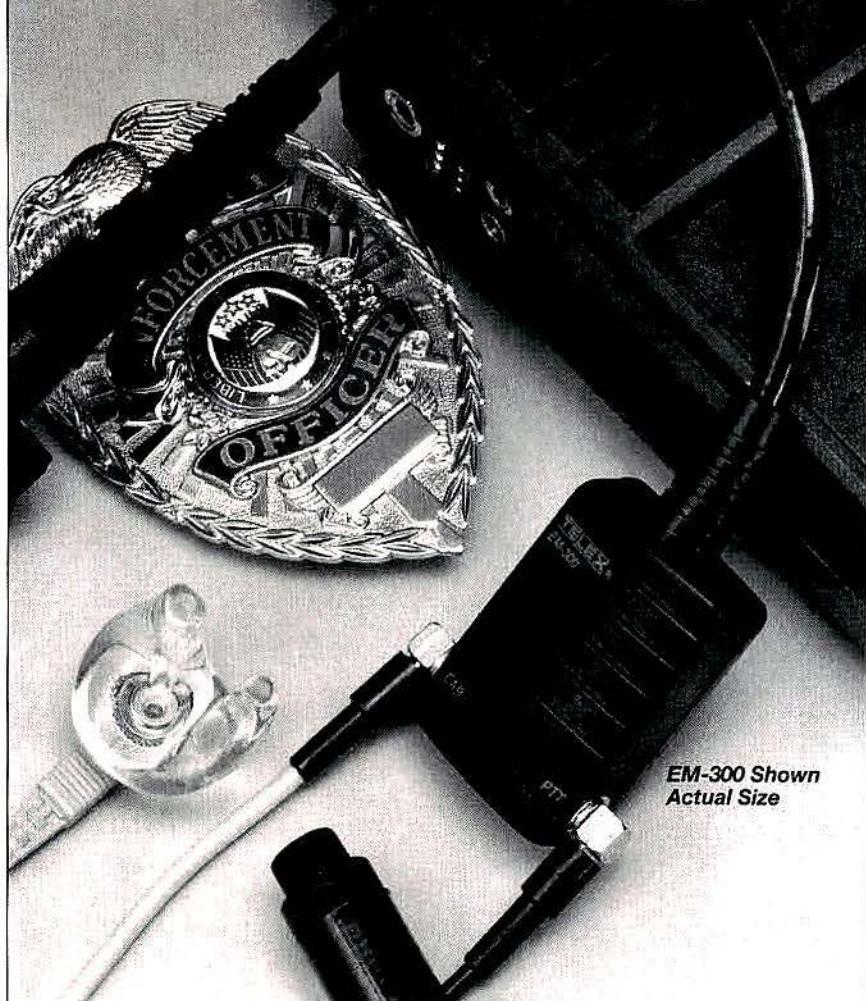


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Circle (71) on Fast Fact Card

# Ear-Mike® With Hidden Advantages



## Telex EM-300 Reliable and Discreet

**NEW!** Our smallest Ear-Mike yet, the EM-300 delivers the performance you expect in a size that may surprise you. The easy to conceal unit is a discreet 1½" long, 1" wide and ½" thick. But it contains all the power you need for covert communications.

The EM-300 features an exclusive *signal shaping* circuit, which reverses loss in intelligence caused by digitally encrypted signals. And because it derives power from the portable radio, no batteries are required. The EM-300 may be purchased with a palm, ring or velcro push-to-talk switch for virtually hands-free operation.

Unlike our competitors' expensive "disposable" products, the EM-300 features removable PTT and ear cords, so in case of damage, you can replace *them* instead of the entire unit. The back panel also removes for easy servicing or replacement of radio cable.

You can depend on the EM-300 Ear-Mike for discreet communications. To find out more, contact Telex Communications, Inc., at 9600 Aldrich Ave. So., Minneapolis, MN 55420, (612) 887-5530.

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**TELEX**

Circle (72) on Fast Fact Card

## New products

### Termination panel has built-in LTR trunking format

IDA model 20-27 tone remote termination panel has the LTR protocol factory-programmed within its microprocessor so that any standard tone remote controller can be used to control E. F. Johnson Challenger radios through the mic jack via the serial port. Other features include PC programmability, 2- or 4-wire audio, 11-function tone decode, 10 outputs, local mic jack and a rugged metal case.

Circle (408) on Fast Fact Card

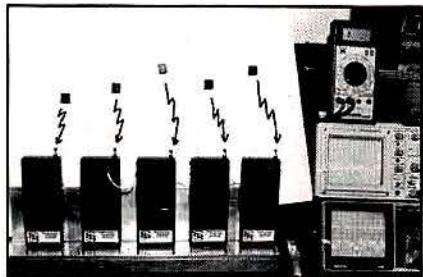
### Mobiles offer 99 channels, scanning, CTCSS, DCS



Uniden's IMU3100KT and IMH4100DT are 99-channel synthesized, dash-mounted, two-way mobile radios that feature scanning, multiple CTCSS and DCS. The IMU3100KT covers the 450MHz-470MHz frequency range and offers 30W of power. The IMH4100DT covers frequencies between 150MHz and 174MHz and boasts 40W of power. Both mobiles meet or exceed the Mil. Spec. 810 C, D and E requirements.

Circle (409) on Fast Fact Card

### Wireless telemetry system provides analog, digital data transmission



Model 5007 telemetry system from Solid State Electronics uses 1 to 5 FM transmitters and FM receivers to provide data acquisition. The design is solid-state and is a solidly encapsulated wireless system for remotely transmitting 1 to 5 channels of analog and digital data. This is a reliable and convenient wireless method of extracting measurement data from systems that are in severe rotary, linear, vibrating or complex motion.

Circle (410) on Fast Fact Card

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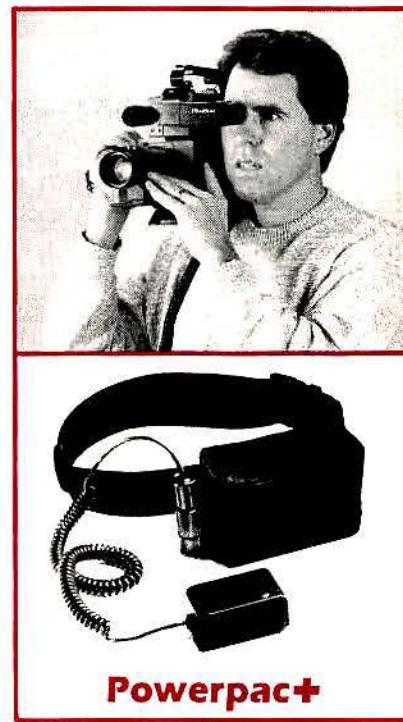
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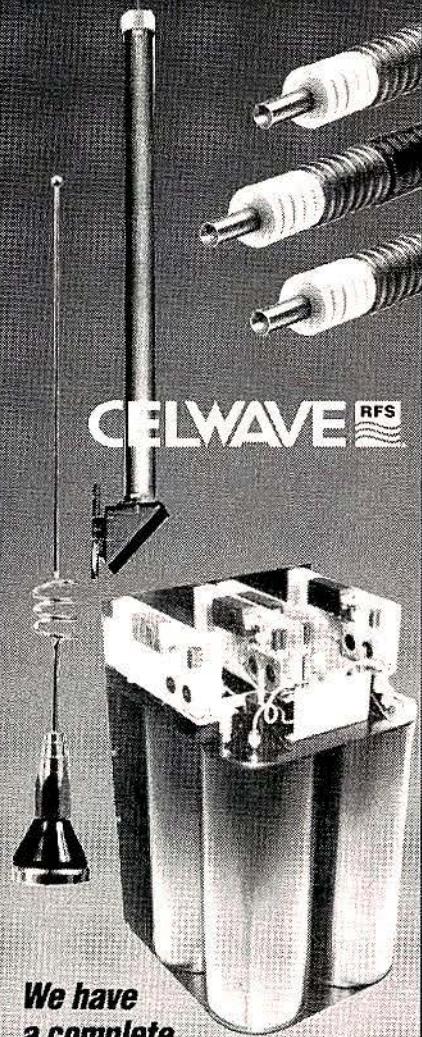
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Circle (74) on Fast Fact Card

## New products

### Converter features vibration-proof design

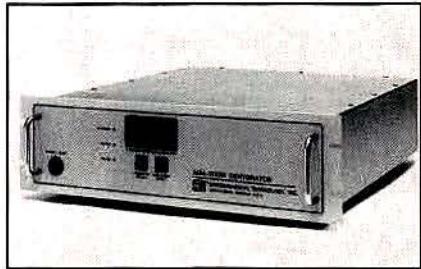


The industrial series 15 model ICT2412-15AS from ICT is a 15A converter with a vibration-proof design. The circuit board features conformal coating to ensure moisture resistance, and the use of a terminal block guarantees a reliable wiring connection. Other features include a compact case and easily accessible mounting holes.

Circle (411) on Fast Fact Card

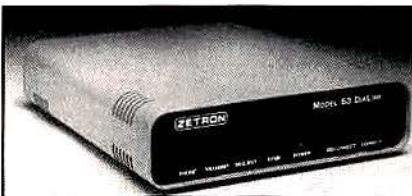
### Air dehydrators work in parallel operations

Environmental Technology's ADH-2COM waveguide air dehydrators can be paralleled for applications: one dehydrator pressurizes while the second is held in standby. The dehydrators communicate with each other through RS-422 serial communications ports, thus providing cooperative operation and equalizing air pump operating times while increasing air flow in the event of excessive leakage.



Circle (412) on Fast Fact Card

### Link allows pages to be sent to remote transmitters



Zetron's model 63 DiaLink is a small paging terminal accessory that allows a paging terminal to control a remote paging

transmitter over a low-cost, dial-up telephone connection. A "master" DiaLink is installed at the paging terminal, and a "remote" DiaLink is at each paging transmitter to be remote-controlled. A maximum of 16 telephone numbers can be dialed by the master DiaLink. The unit is programmable by Touch-Tone, allowing the telephone numbers to be changed by the owner from a telephone.

Circle (413) on Fast Fact Card

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Most models include rugged fiberglass radomes to insure reliable operation in icing conditions, a very important consideration at 900 MHz. Designed by Scala and Kathrein, manufactured by Scala in the USA and backed up by Scala's 35-year reputation for the finest customer service, these antennas are "preferred by professionals" around the World for optimum system performance.

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### OMNIDIRECTIONAL ANTENNAS

| <u>Model</u>         | <u>Gain</u> | <u>Bandwidth</u> | <u>Pol</u> | <u>Type</u>                             |
|----------------------|-------------|------------------|------------|---|
| UBO-900 (K-7511641)  | 0 dBd       | 860-960 MHz      | V          | Radome-protected Collinear Dipole Array |
| OGB3-900 (740-251)   | 3 dBd       | 890-960 MHz      | V          | Radome-protected Collinear Dipole Array |
| OGB6-928 (740-195)   | 6 dBd       | 928-953 MHz      | V          | Radome-protected Collinear Dipole Array |
| OGB6-900 (K-7516641) | 6 dBd       | 890-960 MHz      | V          | Radome-protected Collinear Dipole Array |
| OGB9-900 (740-189)   | 9 dBd       | 890-960 MHz      | V          | Radome-protected Collinear Dipole Array |
| SL-8 Paraslot®       | 11.5 dBd    | 928-953 MHz      | H          | Radome-protected Eight-Bay Slot Array   |

### DIRECTIONAL ANTENNAS

| <u>Model</u>        | <u>Gain</u> | <u>Bandwidth</u> | <u>F/B</u> | <u>Pol</u> | <u>Type</u>            |
|---------------------|-------------|------------------|------------|------------|------------------------|
| TY-900              | 10 dBd      | 890-960 MHz      | 20 dB      | V/H        | YAGI                   |
| RY-900              | 10 dBd      | 890-960 MHz      | 20 dB      | V/H        | Radome-protected YAGI  |
| CL-900              | 8 dBd       | 800-960 MHz      | 35 dB      | V/H        | Radome-protected LOG   |
| LP10-900 (K-732261) | 10 dBd      | 790-960 MHz      | 25 dB      | V/H        | Radome-protected LOG   |
| BP6-900 (A-6335641) | 6 dBd       | 870-960 MHz      | 25 dB      | V          | Radome-protected PANEL |
| BP9-848 (740-217A)  | 9 dBd       | 790-960 MHz      | 20 dB      | V          | Radome-protected PANEL |
| BP11-875 (740-028)  | 11 dBd      | 790-960 MHz      | 20 dB      | V          | Radome-protected PANEL |
| BP13-875 (A-633061) | 13 dBd      | 790-960 MHz      | 20 dB      | V          | Radome-protected PANEL |
| BP16-875 (740-215)  | 16 dBd      | 790-960 MHz      | 20 dB      | V          | Radome-protected PANEL |
| MF-900              | 14 dBd      | 890-960 MHz      | 23 dB      | V          | MINIFLECTOR®           |
| PR-900              | 18 dBd      | 890-960 MHz      | 25 dB      | V/H        | PARAFLECTOR®           |

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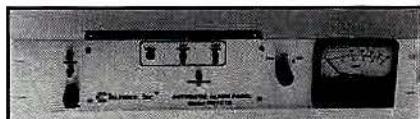
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## New products

### Alarm panels feature built-in wattmeter, 3.5-inch meter display



The PM1C1S one-channel and PM5C1S five-channel alarm panels feature high VSWR and a built-in wattmeter. The 19-

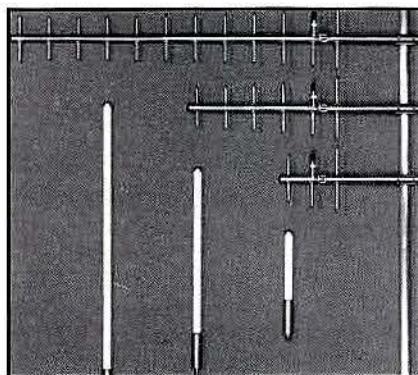
inch panels mount directly inside most base station cabinets and can be powered directly from 120Vac or 12Vdc. The alarm panels from **Telewave** operate as in-line wattmeters measuring forward and reverse RF power with readings displayed on a 3.5-inch meter.

Circle (414) on Fast Fact Card

### Omnidirectional, directional yagi antennas feature gold-anodized mounts

**Antenex** expands its base antenna product line with omnidirectional and directional yagi antennas. The omnidirectional fiberglass base antennas have a gold-anodized mounting sleeve and a strong filament-wound fiberglass radome. Models are available in unity, 3dB and 5dB versions.

The directional yagi antennas have a computer-optimized design and are made of completely welded gold-anodized 6016-T6 aluminum. Models are available in 6dBd, 7.1dBd, 9dBd, 9.2dBd, 10.2dBd and 11dBd.



Circle (415) on Fast Fact Card

### Lowband portable covers 30MHz-50MHz frequencies

The Patriot lowband RTX-050 portable radio from **Ritron** offers 11-channel capability, 5W of power, channel scan feature, tone-coded squelch, digital coded squelch and two-tone sequential decode. The radio measures 6.75" x 2.5" x 1.5" and weighs 18 ounces with the battery. It covers the 30MHz-50MHz frequency band.

Circle (416) on Fast Fact Card

### Software manages cellular usage, eliminates scare when bill arrives

The BudgetWatch software module allows the cellular carrier to assign budget limits for their subscribers' usage through an automated system. Once a user reaches 80% of their budget, BudgetWatch will inform the user of their current balance and that they have 20% usage remaining. BudgetWatch from **Subscriber Computing** also allows an individual with a limited credit history to set up a monthly budget to ensure they do not exceed their ability to pay. The module can accommodate any budget dollar amount for each phone.

Circle (417) on Fast Fact Card

| Police/Fire Comparator Display |                |                |                |
|--------------------------------|----------------|----------------|----------------|
| East Police                    | West Police    | Central Police | North Police   |
| Indian Hill                    | Miami Heights  | Williamson Rd  | Comm Center    |
| Williamson Rd                  | Calhoun Hall   | Greenhills     | Indian Hill    |
| Blendale W.T.                  | Cheviot        | Engineers      | Miami Heights  |
| Comm Center                    | Comm Center    | Glendale W.T.  | Calhoun Hall   |
| Indian Hill                    | Mt. Echo       | Calhoun Hall   | Greenhills     |
| Blendale                       | Miami W        | Comm Center    | Loveland W.T.  |
| Indian Hill                    | Greenhills     | Mt. St. Joseph | Mt. St. Joseph |
| Blendale                       | Cleves         | Sweetwine      | Sweetwine      |
| Indian Hill                    | Fernald        | Miami W        | Miami W        |
| Blendale                       | Pov. Hosp.     | Glendale W.T.  | Blendale       |
| Indian Hill                    | Mt. St. Joseph | Marion         | Marion         |
| Blendale                       | Engineers      | Hillford       | Hillford       |
| Indian Hill                    | Miamitown      | Cheviot        | Cheviot        |
| Blendale                       | Harrison       | Cleves         | Cleves         |
| Indian Hill                    |                | Williamson Rd  | Pov. Hosp.     |
| Blendale                       |                | Williamson Rd  | Fernald        |
| Indian Hill                    |                | Mt. Echo       | Mt. Echo       |
| Blendale                       |                | Engineers      | Fernald        |
| Indian Hill                    |                | Miami W        | Miami W        |

### Remote Comparator Display

The Smartswitch II™ Remote Comparator Display monitors and controls voting receiver systems on a personal computer or console. It can be used locally or remotely with leased-line or dial-up modems.

Now you can **get control** of your voting system.

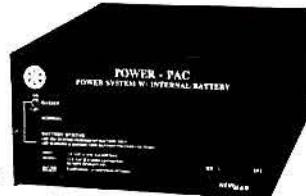


**Combined Technologies, Inc.**  
(513) 595-5900

Circle (77) on Fast Fact Card

### How To Tell If Your Base Station Needs A Newmar Power-Pac ... Pull the Plug.

If your communication system dies when you have an interruption in AC power, you need the NEWMAR Power-Pac. It's a 20 amp power supply with a built-in back-up battery which acts as an uninterruptible DC supply when AC power is down.



The Power-Pac's sealed deep cycle 7 amp/hour battery is normally floated at full charge by the supply. If AC power is interrupted, the battery automatically takes over powering the radio. This assures your communication system is up when it is needed most during a power outage.

Power-Pac, when operating on battery back-up can power a 25 watt radio for up to two hours, based on a 20% tx/rx duty cycle. Indicators on the front panel alert the operator to system status.

Get your base station ready for the next power outage - Use a Power-Pac.

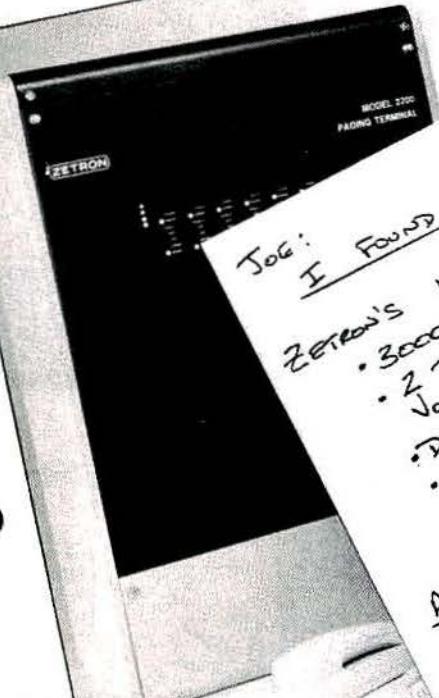


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Fax: (714) 957-1621

Circle (78) on Fast Fact Card

## 2000 SERIES Paging Terminals

**ZETRON**



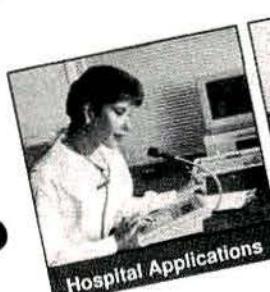
Zetron models 2100 and 2200

*Sgt. I Found A Better Deal!*

- Zetron's Model 2200, WITH:
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- 2 TELCO TRUNKS THAT SUPPORT
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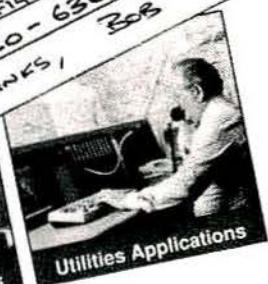
Hospital Applications



RCCs and PCPs



Industry Applications



Utilities Applications

**ZETRON, INC.**

12335 - 134th Court NE  
Redmond, WA 98052-2433  
(206) 820-6363 FAX: (206) 820-7031

## New products

### Compact GPS unit stores as many as 99 destinations

The KX-G5500 global positioning system (GPS) receiver from **Panasonic** offers full navigational functions and an internal memory that stores as many as 99 waypoints (destinations) plus nine preprogrammed routes. For use on land or off, the five-channel receiver can display latitude, longitude and altitude. The receiver measures  $5\frac{1}{2}'' \times 2\frac{5}{8}'' \times 1\frac{1}{2}''$  and weighs 11.6 ounces.



Circle (418) on Fast Fact Card

### Software simplifies base station antenna calculations



RF Tools software program from **Antenna Specialists** helps communication

system designers and operators with base antennas calculate and tailor antennas to their own system requirements. Three disks are included: Dxplot permits precise calculation of beamtilt coverage; Patplot displays and plots digitized base antenna patterns; and Antplot develops patterns for side-mounted base antennas. The programs are available on 5.25-inch IBM-compatible disks, or they can be downloaded through Antenna Specialists' remote bulletin board system.

Circle (419) on Fast Fact Card

### Battery charger offers interchangeable cups

The Multi-Charger from **Multiplier** has a base unit with interchangeable cups to condition and rapid-charge two-way radio and cellular phone batteries. Other features include optional deep discharge conditioning; conditioning and charging of nickel metal hydride batteries; and ac/dc adapters for home, office or vehicle charging.

Circle (420) on Fast Fact Card

### Scanning portables offer 16-channel capabilities

The SPH516DT 5W VHF and the SPU416KT 4W UHF are 16-channel scanning portable radios from **Uniden**. The VHF model covers 150MHz-174MHz, and the UHF model covers 450MHz-470MHz. Both models are synthesized and feature high/low power switch, a programmable battery saver and multiple CTCSS and DCS. Other options are DTMF keyboard, heavy-duty battery, battery pack for alkaline cells, trickle or rapid chargers, speaker microphone and a narrowband IF kit for 12.5KHz channel spacing.

Circle (421) on Fast Fact Card

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### Tampering with Motorola's Communication Technology is Nothing Short of a Crime.

Motorola has been at the forefront of communications technology for more than 60 years. Today, we offer a greater array of communications products than ever before. We are proud of our products and the vital services they bring to our customers which are of unparalleled public importance.

Theft of communications services and so-called High-Tech piracy threaten the entire communication industry's reputation for reliability. This conduct

not only damages the reputation of Motorola, Inc. and the communications industry, but undermines the very integrity of America's public and private communications services.

Motorola intends to combat this conduct by aggressively maintaining and enforcing its proprietary rights to its hardware and software technology. Anyone who has knowledge of illegal activities or has questions concerning such activities is urged to contact Motorola Inc. immediately at 1-800-325-4036. Contacts will be kept confidential and may be made anonymously.



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## New products

### Telescoping tower offers portable tower solution

The GME telescoping tower is 15'6" in its closed position on the trailer and weighs 157 pounds. The trailer that the tower is mounted on is equipped with outriggers to stabilize the tower in high winds. By using a hand-cranked winch system, the 50-foot tower can easily be erected with minimum time and manpower. The tower uses stainless steel bolted assembly rather than welding for strength and durability.

Circle (422) on Fast Fact Card

### Base station antennas withstand 150mph wind without ice



Power Master heavy-duty, high-gain, omnidirectional fiberglass antennas feature a "cool blue" design that blends with the skyline and absorbs the rays from the sun to assist in de-icing the antenna. The antennas' strong interwoven fiberglass housing withstands wind loading of as much as 125mph with 1/2-inch of radial ice or 150mph wind loading without ice. Telewave models include ANT150F6, 138MHz-174MHz, 6MHz bandwidth and 6dB gain; ANT220F6, 216MHz-225MHz, 9MHz bandwidth and 6dB gain; ANT450F6, 450MHz-470MHz, 20MHz bandwidth, 6.2dB gain; ANT450F10, 450MHz-470MHz, 20MHz bandwidth and 10dB gain; and ANT860F10, 806MHz-866MHz, 60MHz bandwidth and 10dB gain.

Circle (423) on Fast Fact Card

## Solar/Cell Batteries



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Circle (83) on Fast Fact Card

### Crimp plugs fit land mobile, cellular equipment

The RFU-600-6 mini-UHF crimp plug for RG58/U cable is machined from solid brass, nickel plated and has a gold-plated brass crimp pin. The cable crimps both the pin and the shield crimping to the ferrule stud of the connector.

The RFU-600 field installable mini-UHF plug for RG58/U cable can operate past 1.5GHz and handles power in excess of 150W, with VSWR of less than 1.2 to 1. The "no-tool" plug is ideal where a fitting is considerably smaller than a BNC. The connectors from **RF Industries** are useful on Motorola's land mobile and cellular radio equipment.

Circle (424) on Fast Fact Card

### Repeater may be used as part of system, independently

The RTL-1000R from **Telepoint** is a full-duplex back-to-back or crossband repeater that may be used to extend range or to overcome path obstructions to provide proper signals to the subscriber's location. The unit may be used independently or as part of the Unitel RTL-1000 microprocessor-controlled radiotelephone link.

Circle (425) on Fast Fact Card



### Headset uses split audio, reduces multiple radio traffic confusion



The Setcom split audio headset provides OSHA-approved hearing protection and the capability to broadcast and receive on two radios, AM or FM. The headset uses split audio to reduce multiple radio traffic confusion. The tower radio is heard in the right ear; dispatch in the left. The operator talks through a noise-cancelling lip microphone.

Circle (426) on Fast Fact Card

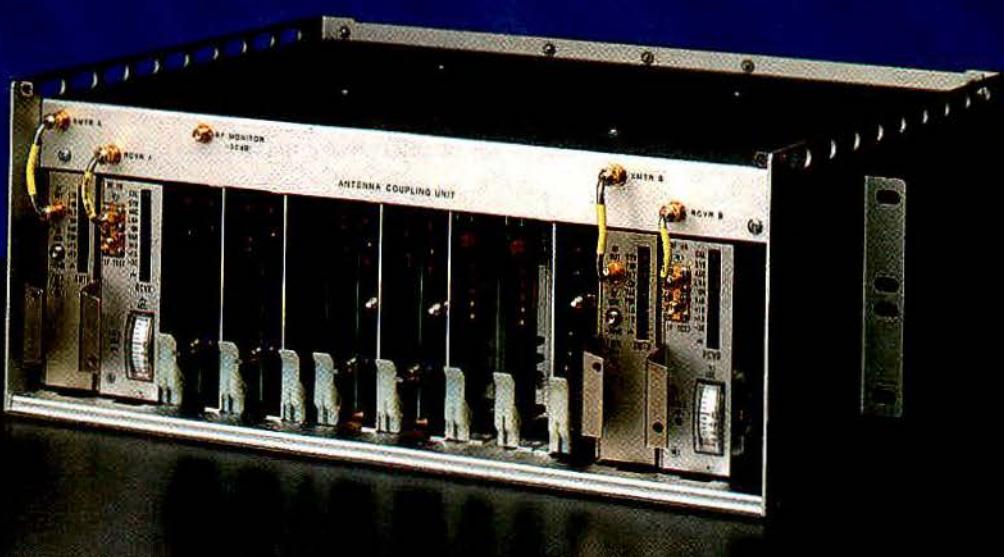
### MDT software suits user's individual needs

The Express mobile data terminal from **Mentor Engineering** has its own form-based operating system (FBOS). The FBOS provides software background for programmable forms, function keys and software menus so that the Express MDT software can be tailored easily to suit each customer's application requirements. The Express MDT features an optional alphanumeric keyboard and multiple serial ports for connecting to peripheral devices, such as GPS receivers, printers, card readers and third-party data networks.

Circle (427) on Fast Fact Card



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## New products

### Digital audio recorder records for two hours

The **Addcom** digital audio recorder allows as much as two hours of high quality audio recording without tapes. Each call is individually date and time stamped and has a caller ANI option, DTMF or FSK decode. Individual calls may be reviewed

without disturbing recording functions because of a simultaneous record and playback feature. All recordings saved as a cassette tape archive include date, time and ANI information.

Circle (428) on Fast Fact Card

### Paging encoder offers 12 two-tone calls

The PE-12 is a 12-call paging encoder using the two-tone sequential paging format. Packaged in a high impact plastic case with a mounting bracket, the unit from **Communications Specialists** is configured for mobile base stations that need to signal a handful of pagers with discrete calls.

Circle (429) on Fast Fact Card



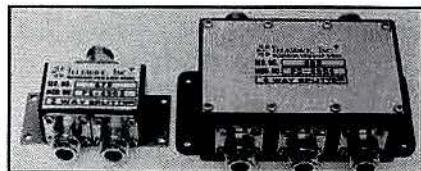
### Software package aids in design, management of microwave network

The Multiplex channel Accessing, Planning, Networking and Equipment Tasking (Mapnet) software package helps in the design and management of microwave networks. The software from **Nucomm Data** makes multiplex channel assign-

ments for new service or service reassignment and automatically seeks an available circuit path from an internal database. The software operates in Microsoft Windows 3.x and uses a visual graphics map interface with a selection of map data.

Circle (430) on Fast Fact Card

### Power splitters provide system design flexibility



Two-way and four-way power splitters from **Telewave** provide flexibility in system design and minimize cost for interconnect cables by providing two or four

outputs from one input. Models include: PS-302 lowband two-way splitter for 33MHz-50MHz; PS-1502 VHF two-way power splitter for 132MHz-174MHz; PS-4502 UHF two-way power splitter for 400MHz-512MHz; PS-8902 800/960 two-way splitter for 806MHz-960MHz; PS-1504 VHF four-way power splitter for 132MHz-174MHz; and PS-4505 UHF four-way power splitter for 400MHz-512MHz.

Circle (431) on Fast Fact Card

### Repeater/base station supports simulcasting, voice and data

Microprocessor-controlled and engineered for high-density sites, the Eclipse line of frequency-synthesized VHF and UHF repeater/base stations made by **RF Technology** are compatible with simulcast operations. The modular units fit 19-inch racks and come with SWR and thermal protection. With 100W-rated power am-

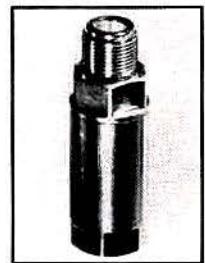
plifiers (50W continuous), the units have a 100-channel capacity, programmable CTCSS and built-in alarm functions. Diagnostics are available, and the units are DCS repeat capable. They boast 20mS transmit-receive switching for efficient data transmission. The units are FCC and DOC approved.

Circle (432) on Fast Fact Card

### Connectors fit 1/2", 7/8" corrugated cables

#### RF Industries'

corrflex cable connectors fit popular 1/2" and 7/8" foam dielectric corrugated cables. Installation takes 3-5 minutes, and no special tools are required, although a simple copper tube cutter is helpful. After installation, the connector offers more than 250 pounds of pull strength against the cable.



Circle (433) on Fast Fact Card

### Repeater panel active for 160 user groups



The 38-Max repeater panel from **Zetron** has 50 subaudible tones and 110 digital codes. All of the tones and codes may be active simultaneously for a maximum of 160 user groups. The 38-Max may be programmed by DTMF over the radio channel or by a PC connected directly or via modem to the RS-232 port built into the front panel. The unit has an internal airtime accumulator that compiles a record of how much airtime is used by every subaudible tone and digital code.

Circle (434) on Fast Fact Card

### Pager offers colorful covers



The Lifestyle Plus pager from **Motorola** has a 12-digit numeric display, 16 message slots, message time stamping and silent vibration. The pager features time-of-day display, message lock for as many as four messages and a backlit display. Contemporary color covers include smoke, ice, ultraviolet, totally teal and arctic white.

Circle (435) on Fast Fact Card



Synthesized, Field Programmable  
 11 channels  
 5 Watts VHF/UHF  
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 Frequency Bands: 136-174  
 400-430, 450-512 MHz  
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Portable comes with: battery, antenna, wall charger and belt clip.  
 Optional accessories: DTMF keypad, speaker microphone, earphone or headset, fast rate drop-in charger and carry holster.

Mobile comes with: installation kit, hand microphone and external speaker jack. Optional accessories: DTMF hand microphone and 5 watt external speaker.

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support from the factory. It's true we have Patriot radio dealers worldwide, but right now a limited number of dealerships are still available. So take advantage of a truly patriotic deal, and call us at 1-800-USA-1-USA. **PATRIOT**  
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Circle (85) on Fast Fact Card



Two Year Warranty applies to product sold in USA. Certain frequency bands special order.

## *New products*

Analyzer covers 1MHz-1,000MHz frequencies

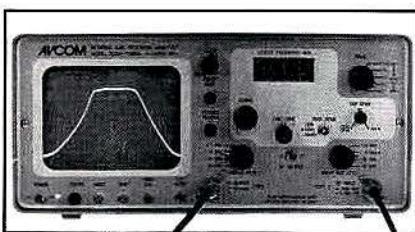
**Avecom's NASA-1000A** can be used as a stand-alone 1MHz-1,000MHz spectrum analyzer with an internal FM demodulator or used as a network analyzer by activating the built-in tracking generator. The unit is ideal for receiver and transmitter alignment and troubleshooting, and RF communication system testing. It measures 11.5" x 5.5" x 15.5" and weighs 18 pounds.

Circle (436) on Fast Fact Card

**System detects presence of lightning; disconnects, grounds equipment**

The ILD-P lightning protection system detects the presence of lightning when a storm is typically 2-5 miles away and protects equipment by automatically disconnecting and grounding power sources, telephone lines and coax cables. Features include a bargraph which shows line disturbances and/or lightning in the area and a special disable mode which will not allow the equipment to power down while in use. The system from **Rabun Labs** is designed for land mobile base station equipment.

Circle (437) on East East Card



### **Cables offer lower attenuation, flexibility**

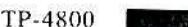
The SFT series of cables from **Times Microwave Systems** uses high-performance taped PTFE dielectric for lower attenuation and greater flexibility. The SFT cables are fully tested for guaranteed attenuation and VSWR performance.

Circle (438) on East Fact Card

## Trunking portable offers five scan modes

The TP-4800 800MHz portable radio features trunked and conventional operation with 10 systems and 10 groups; 100 conventional channels; programmable talk around; and five scan modes: system, auto group, user-activated group, Rx priority and first available system. The DTMF keypad allows for storage and recall of eight telephone numbers. The alphanumeric display has a 7-character LCD and icons, and it is backlit for easy viewing. The radio from **Maxon** measures 7" x 2.5" x 1.5" and weighs 1 lb. 7 oz.

Circle (439) on Fast Fact Card



### Soldering control station provides precise temperature settings



The Antex TCSU-1 temperature control station features a sliding potentiometer that provides precise temperature control settings and a 30W precision miniature soldering iron that is safe for use with heat and sensitive components. The soldering control station from **M.M. Newman** is powered by 115Vac and converts the line voltage to 24V. Tip temperatures adjust from 160° to 815°F, and the soldering iron's heating element is under the tip for optimum thermal efficiency.

Circle (440) on Fast Fact Card

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- 3-D Terrain
- Coverage Predictions
- Fresnel Zone Studies
- Engineering Package
- Intermodulation Studies
- 3 or 30 Second Terrain Files

◆ FCC INFORMATION

- Dial Access
- State Frequency Lists
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Circle (87) on Fast Fact Card

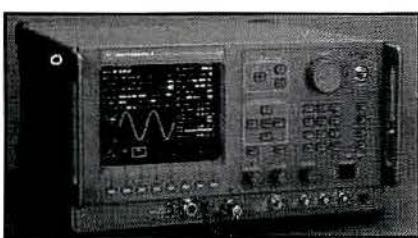
**Batteries feature low self-discharge in 7.2V, 8.4V, 9.6V**



**Plainview Batteries'** 7.2V, 8.4V and 9.6V NiCd batteries feature low self-discharge, high energy storage, stable discharge voltage and low internal impedance. The batteries come in three standard packages as well as replacement applications. The 9.6V model can be recharged more than 500 times.

Circle (441) on Fast Fact Card

**System analyzer services conventional two-way radios**



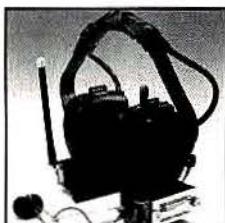
**Motorola's** R-2550 provides a fully variable output level duplex generator and automatically calibrated spectrum analyzer for servicing conventional two-way radios. Features include a 7-inch diagonal CRT, lightweight and portable styling, and digital storage scope.

Circle (442) on Fast Fact Card

**Headset features rotary volume control**

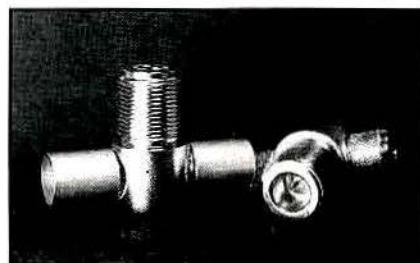
Variable volume control is a new feature with **Earmark's** Series IV headsets. It allows the user to adjust the incoming volume with a turn of a knob without worrying about environmental noises flooding the network. Located behind the receiver earcup, the rotary switch is easy to find and large enough to control with a gloved hand. The self-adjusting Series IV headset is listed as intrinsically safe by UL and is backed with a three-year parts and labor warranty.

Circle (443) on Fast Fact Card



**Type N tee connector offers design versatility**

**Delta Electronics'** tee connectors are useful for tapping a signal transmitted through a coaxial cable in mid-line, or feeding two duplexed signals into a single receptacle. The connectors are available in crimp attachment for flexible cables or solder-type for semi-rigid cable. The connectors meet MIL-C-39012 specifications and are equivalent to MIL-C-39012 type N right-angle connectors for coaxial cable.



Circle (444) on Fast Fact Card

**Page buffer offers 120 seconds of storage time**

**Model 55B** from **Zetron** is a storage device designed to enhance the operation of a remote paging transmitter that experiences co-channel activity. Installed between the transmitter and the link to the central paging terminal, the page buffer stores analog and digital pages that are received from the link and then forwards them to the transmitter when the channel is clear. Features include 120 seconds of storage time, enough to store as many as



eight 12-second voice pages or more than 100 digital pages; an elastic buffer that receives and sends simultaneously, preventing lost pages; and a software-based VOX detector.

Circle (445) on Fast Fact Card



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Circle (88) on Fast Fact Card

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Circle (89) on Fast Fact Card

## Catalog features tone signaling products

The 25th anniversary free catalog from **Communications Specialists** contains listings and brief descriptions of CTCSS and digital CTCSS encoders and decoders, repeater products, paging encoders and decoders, and other miscellaneous tone

devices. The catalog features the new ID-8 Morse station identifier and PE-15 paging encoder for local addressing of POCSAG display pagers. Included in the catalog is an application note on putting together a low-cost mobile paging encoder.

Circle (300) on Fast Fact Card

## Electronic bulletin board covers RF propagation software

TeleTAP is an electronic bulletin board that can be accessed at no charge by both existing and prospective **SoftWright** customers. E-mail can be left for both sales and product support departments. Many types of demonstration software are available for downloading at no charge, and

callers can receive answers to frequently asked questions or ask their own to learn some basics about RF propagation software. Authorized Terrain Analysis Package (TAP) users are given access to software updates and E-mail to all other TAP users through TeleTAP.

Circle (302) on Fast Fact Card

## Catalog describes vehicular land mobile antennas

A vehicular land mobile catalog gives details on all of **Mobile Mark's** antennas and accessories. It lists the lowband, VHF, UHF and trunking antennas for mobile applications. The lowband Heliwhips are included, as well as new products such as the flexible whip RF series antennas for trunking applications. Model numbers and descriptions are listed with each product, as well as electrical and mechanical specifications.

Circle (304) on Fast Fact Card

## Book includes FCC regulations

*The NABER Resource: FCC Rules, Regs & Licensing* includes FCC regulations for Part 17. This section addresses tower maintenance, lighting and other tower issues. The book provides an updated Part 90, containing rule changes through Jan. 1, 1993. Also contained in the book are a how-to guide for completing FCC forms; a subject index; an annual review explaining all rule changes that occurred in 1992; and an updated listing of all FCC field offices and FCC-certified frequency coordinators.

Circle (305) on Fast Fact Card

## Data sheet illustrates trunking radiotelephones

A data sheet from **RTX** describes the features and advantages of the RTX 8700 series Bagphones, which are available in full-duplex and half-duplex models. The

data sheet covers how both models of the 25W VHF and UHF units will work with any RTX-compatible controller.

Circle (306) on Fast Fact Card

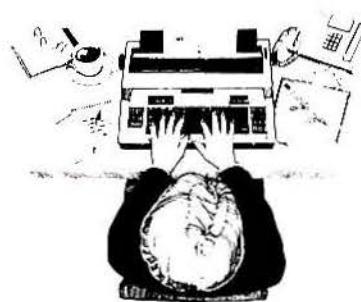
## Express yourself

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Send a letter to:

Letters to the editor  
*Mobile Radio Technology*  
P.O. Box 12901  
Overland Park, KS 66282-2901



## Brochure covers base station antennas

An eight-page brochure shows base station antennas for both nationwide and non-nationwide 220MHz-222MHz services, coaxial cables and accessories, and mobile antennas for On-Glass, hole and magnetic mounting. Individual product data sheets are also available from **Decibel**.

Circle (301) on Fast Fact Card

## Coaxial connector catalog includes 150 new items

A 36-page catalog from **RF Industries** presents an expanded range of coaxial connectors, including 150 new items. Extensive coverage of BNC, TNC, N, UHF, Mini-UHF, MB, SMB, SMA, SMC and  $\frac{1}{2}$ " and  $\frac{7}{8}$ " corrugated cable connectors. The catalog includes more than 750 coax products, including cable assemblies, connector kits, unidapt and celludapt universal adapter products.

Circle (303) on Fast Fact Card

## Catalog features miniature rechargeable batteries

A catalog from **Plainview Batteries** features standard and custom miniature rechargeable batteries—nickel-cadmium and nickel-metal hydride—in a variety of form factors: axial and radial leads; flat-paks; in Eco-Pak battery holders; with double- and single-mounting pins; and 7.2V, 8.4V and 9.6V assemblies. Included are complete lines of button cells in both chemistries for custom assemblies, and performance curves and recommended charge rates for all products described.

Circle (307) on Fast Fact Card

## Catalog includes mobile radio, paging, SMR equipment

A 400-page catalog shows land mobile radio, SMR, paging, cellular and solar electric equipment. The catalog from **Hutton Communications** features more than 6,000 of their most popular items from more than 80 manufacturers. Products are organized into 20 categories, and the catalog contains more than 400 photos and charts.

Circle (308) on Fast Fact Card

## Brochure describes amplifiers

A brochure from **AML** includes full specifications for 17 power efficient feed-forward, linear power amplifiers. Peak envelope powers range from 7W to 120W with gains to 70dB. Both rack-mount and compact units are described.

Circle (309) on Fast Fact Card

## Reasons for joining a trade association

General interest is the reason 54.8% of the respondents of February's "What Do You Think?" questionnaire joined a trade association. Other reasons include: (multiple answers add up to more than 100%)

|                                     |       |
|-------------------------------------|-------|
| Networking                          | 47.6% |
| 'Political voice' in Washington, DC | 38.1% |
| Seminars                            | 28.6% |
| Training                            | 26.2% |
| Other                               | 28.6% |

Readers are affiliated with the following association:

|                       |       |
|-----------------------|-------|
| NABER                 | 35.7% |
| APCO                  | 33.3% |
| NARTE                 | 16.7% |
| Radio Club of America | 9.5%  |
| AMTA                  | 7.1%  |
| ITA                   | 4.8%  |
| RadioComm             | 4.8%  |
| UTC                   | 4.8%  |
| FCCA                  | 2.4%  |
| Telocator             | 2.4%  |
| Other                 | 14.3% |

Readers commented about the advantages of being a member of an association:

- "Allows closer watch on trends and rulemaking in the industry."
- "Educational opportunities are the most up-to-date and expansive, and the free sharing (of information) between members is better than any school."
- "Keep abreast of job openings, certification standards and technical articles."
- "Larger organizations are available to assist smaller groups within the association."
- "Political action and activities."
- "Common problems are discussed, and avenues are taken to alleviate them."
- "Good current information. Different points of view on similar issues."
- "Seeing new updates on equipment, servicing techniques and servicing aids."
- "Staying abreast of industry and regulatory trends; political representation."

Disadvantages readers noted were:

- "Cost of membership."
- "Too many in-person meetings all around the country. Can't attend due to budget and time constraints."
- "Associations are too focused by user group, i.e., business, police, etc. Would like focus on two-way dealerships who deal with broad spectrum of user types."
- "High dues for what services are received."
- "If active, the time expected of you to devote to the group."
- "None, if you stay out of the political in-fighting, maintaining objective on an issue."
- "To be fully active, it requires a good deal of time, but the rewards are well worth it."



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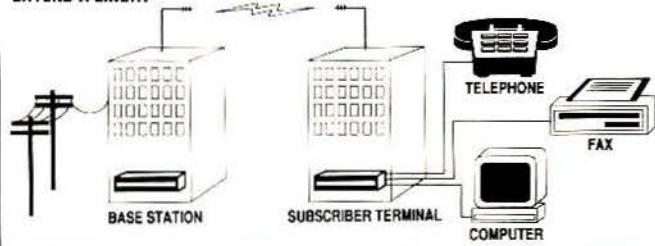
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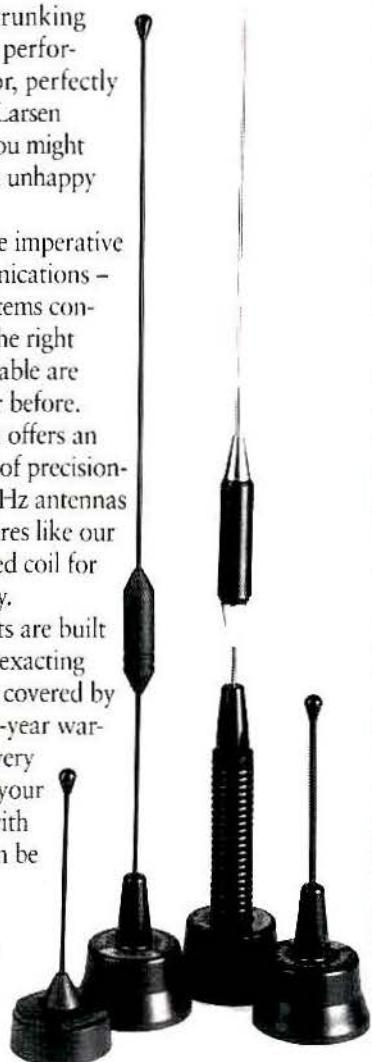
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## P eople



Weiss



Coryelle



Mramor



Brown

**Jamie P. McConaty**, manager of global systems and product development for Ericsson GE, Lynchburg, VA, advances to vice president for the North American region.

**John Weiss**, associate sales manager for Newmar, Newport Beach, CA, advances to national sales manager.

**Thomas E. Wanley** leaves the staff of Rep. Philip R. Sharp of Indiana as legislative director to join Telocator, Washington, DC, as director of government relations.

**Robert P. Denaro** departs Trimble Navigation, Sunnyvale, CA, as vice president and manager of the vehicle tracking and navigation systems division to join Motorola, Northbrook, IL, as director of its position and navigation systems business.

**Jim Coryelle** leaves Telewave, Mountain View, CA, as sales engineer to join Wallace and Wallace, Santa Fe Springs, CA, as a field representative.

Changes at Antenna Specialists, (A/S) Cleveland:

**Charles Mramor** exits Jet, Cleveland, as customer service supervisor to become customer service manager for A/S.

**Michele Brown**, A/S customer service representative, advances to international sales administrator.

The Radio Club of America has elevated the following individuals to the membership status of Fellow:

**Linda D. "Lin" Ford**, historian, Associated Public-Safety Communications Officers, South Daytona, FL; telecommunicator, Greensboro Police Dept. (retired); adviser for the North Carolina Division of Emergency Management ESD Division, Greensboro, NC.

**Robert W. Galvin**, chairman of the executive committee of the board, Motorola, Schaumburg, IL.

**Raymond Minichiello, P.E.**, president, Lapp, Manchester, NH.

**Ronald J. Jakubowski**, system engineering manager, Antenna Specialists, Cleveland.

**Ake S. Persson**, vice president of business development, Ericsson GE Mobile Communications, Research Triangle Park, NC.

**John S. Powell**, president, Associated Public-Safety Communications Officers, South Daytona, FL; sergeant with University of California Police Dept., Berkeley, CA.; and communications coordinator for University of California Police System.

**Willard K. Shaw**, owner, California Trunking, Vista, CA.

# Mobile Radio Technology

The journal of mobile communications technology

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# L etters to the editor

## Directional wattmeters:

I would like to make some specific comments on the article "Mobile, Portable, Base Station Cellular Telephone Antennas" by Roald Steen in the February edition.

Mr. Steen discusses in some detail the importance of using a directional wattmeter when installing a transmitting antenna. This advice is somewhat outdated.

The directional wattmeter is a technology that dates to the '40s and '50s and was intended to solve the problems found in transmitters with vacuum tube final amplifiers, operating at frequencies below about 50MHz, and with tunable pi-nets or l-net matching networks.

These transmitter networks and their accompanying antennas usually had to be manually retuned if the operating frequency was changed even slightly. Today's radios are much different!

Let's take a quick look at the situations commonly encountered today, that the directional wattmeter is a poor choice to handle:

(1) The same antenna is used for transmitting and receiving, and the transmitter cannot be tuned to the receive frequency.

(2) Systems in which the antenna is shared, through a network of isolators, combiners, and cavity filters, among a number of transceivers.

(3) Data links where the transmitter is operated in bursts.

(4) Where moisture and contamination have entered the antenna or transmission line and have increased the system losses.

(5) Control over the radiation pattern is important to the performance of the system.

(6) Environmental factors require that the antenna be tuned at the installation site.

(7) Systems using a wideband technology, like television or spread-spectrum.

(8) Where the manufacturer has included power losses to make the antenna appear as a good VSWR match.

(9) Certifying that coaxial cable runs are free of faults and kinks and that connectors have been properly installed.

(10) Anywhere that a transmitter is unavailable for testing, or where powerful transmitter operation, even for short time periods, is not an available choice.

That the directional wattmeter is still used at all is more a tribute to the stubbornness of technicians and their technical schools than it is to the versatility of the instrument.

Everywhere I go, I see the efforts of engineers and technicians to "kluge" over the wattmeter's shortcomings: special slugs for low power or peak power; wattmeters with band switches; technicians

who put power amplifiers on signal generators so they can use the wattmeter off-frequency; special programmed chips for transceivers to tune more frequencies; costly accessories for spectrum analyzers; custom computer interfaces; and installations with 10 or 20 or even more directional wattmeters permanently left in-line.

The instrument that can do all these things is the RF network analyzer. Just as radio technology changes, so do instrumentation requirements.

Because the network analyzer can be used in a much wider range of situations and can solve a much greater range of problems, it is replacing the directional wattmeter as the instrument of choice for installing and maintaining cellular telephone antennas and two-way radio antenna systems.

Wayne R. Openlander  
Chairman  
Direct Conversion Technique  
Chicago

## Fast Fact Card comments:

The two toughest problems facing me on the job are:

- troubleshooting surface-mount devices (SMDs) on printed circuit boards where the SMDs are on the chassis side of the board, as well as the visible side.

- bad schematics with inadequate information.

Richard J. Wolf  
Lead Technician  
Radicom  
McHenry, IL

The two toughest problems facing me on the job are:

- a lack of awareness in some quarters about automobile electrical noise sources that affect communication performance.

- a lack of standards from vehicle manufacturers about electrical noise.

Jaime G. Arevalo  
RF Design Engineer  
Uniden  
Fort Worth, TX

The two toughest problems facing me on the job are:

- finding reliable radio equipment at an affordable price.

- obtaining new frequencies in crowded areas.

Dana V. Archer  
Communication Officer  
California State University  
Police Department  
Northridge, CA





# C

## classified

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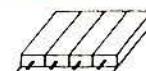
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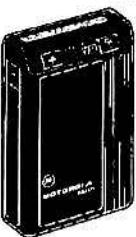
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| 145.174      | 46   | 145.174         | 46   | 145.174        | 46   | 145.174       | 46   |
| 145.174      | 47   | 145.174         | 47   | 145.174        | 47   | 145.174       | 47   |
| 145.174      | 48   | 145.174         | 48   | 145.174        | 48   | 145.174       | 48   |
| 145.174      | 49   | 145.174         | 49   | 145.174        | 49   | 145.174       | 49   |
| 145.174      | 50   | 145.174         | 50   | 145.174        | 50   | 145.174       | 50   |
| 145.174      | 51   | 145.174         | 51   | 145.174        | 51   | 145.174       | 51   |
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| 145.174      | 61   | 145.174         | 61   | 145.174        | 61   | 145.174       | 61   |
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| 145.174      | 89   | 145.174         | 89   | 145.174        | 89   | 145.174       | 89   |
| 145.174      | 90   | 145.174         | 90   | 145.174        | 90   | 145.174       | 90   |
| 145.174      | 91   | 145.174         | 91   | 145.174        | 91   | 145.174       | 91   |
| 145.174      | 92   | 145.174         | 92   | 145.174        | 92   | 145.174       | 92   |
| 145.174      | 93   | 145.174         | 93   | 145.174        | 93   | 145.174       | 93   |
| 145.174      | 94   | 145.174         | 94   | 145.174        | 94   | 145.174       | 94   |
| 145.174      | 95   | 145.174         | 95   | 145.174        | 95   | 145.174       | 95   |
| 145.174      | 96   | 145.174         | 96   | 145.174        | 96   | 145.174       | 96   |
| 145.174      | 97   | 145.174         | 97   | 145.174        | 97   | 145.174       | 97   |
| 145.174      | 98   | 145.174         | 98   | 145.174        | 98   | 145.174       | 98   |
| 145.174      | 99   | 145.174         | 99   | 145.174        | 99   | 145.174       | 99   |
| 145.174      | 100  | 145.174         | 100  | 145.174        | 100  | 145.174       | 100  |

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 T73VXJ7204AK-150-174, 8M, 100W, DES Hi Sec. Housing  
 T74VBJ7D04BK-406-430, 16M, 100W  
 T74VBJ7D04BK-450-470, 16M, 100W, Syst. 90 Access.  
 Syntex  
 T83SRA3800-150-162, 162-174, 12F, 100W  
 T44, 64, 74SRA3200-403-430, PL-8F  
 T44SRA3800BK-450-470, 12F, 50W, Sys 90 Access  
 T44SRA3200BK-482-512, 8F, 50W, Sys 90 Scan Access  
 MCX100  
 MBD23EXA7JOOAK-150-174, 10W, 32F, Dual Prt, Scan DES  
 MBD4EXA7JOOBK-403-430, 30W, DES

MCX1000  
 MBT4LUJA7HOOAK-403-430, 30W, DES, TR Only  
 Mirrex  
 T51JJA1000AK-29-7-38-999, 60W, CS4F  
 T43, 53, 63JJA1000-148-174, 4F, CS & PL  
 T64JJA3100-450-470, 75W, PL, 4F  
 T45JJA6000AK-800, MC, 35W, 4F  
 PAC RT5  
 H14TY3110-450-470MC  
 GE  
 MC74AAS32A-36-42, 100W  
 MC74CCS66A-150-174, 100W  
 EX76CCS66A-150-174, 100W & Auxiliary RX

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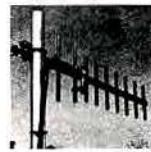
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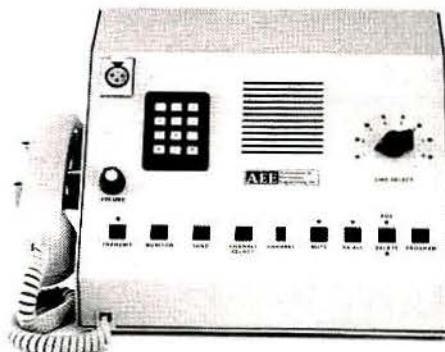
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#### RECENT SYSTEM ARRIVALS

|   |            |
|---|------------|
| MDC 4800 Signalling System Consisting of:   |            |
| MOT "MSF500" 75W analog (digital capable) duplex base stn. (C65CLB7206)—possible purc/trkng use (Qty. 16)   | \$4500     |
| "GCC480" gen'l. comm. controller (Q2007AG)  |            |
| E/W UDS 201 B/W/T 4W modem (2DN6426)  | \$800      |
| DB prod. 4-cavity B/P dplkr. (SP8303)   | \$400      |
| RDX Portable Data Systems (1 New, 1-USED) consisting of:  |            |
| MOT "Micor" 2-12W base stn., c/s (C24RCB105-SP390)  | \$1200/900 |
| MOT 2-cavity dplkr (T1503)  | \$200/150  |
| MOT RDX100 control unit (NI2596)  | \$600/300  |
| MOT RDX100 portable RF data terminal (NI257A) w/o N.Cd  | \$100/50   |
| MOT spare circuit bos (LN5074)  | Offer      |
| NOTE: System is compatible w/IBM 3270 info dis. sys. 450MHz Paging System, T&V. (453-125MHz) consisting of: |            |
| MOT "Micor" 250W base stn. PL. DC (B64RCB105)   | \$2600     |
| MOT "Modax 500" w/U.N. I (E08/DS1000)   | \$500      |
| MOT (200) "Sprint" pagers w/o batt. cover, filters, chgr. \$25  |            |
| TOTAL SYSTEM PRICE: \$3500  |            |

#### BASE STATIONS

|   |             |
|---|-------------|
| MOT "Micor" 450MHz, 250W, C/S DC (384RCB)                 | \$2600      |
| MOT "Micor" 450MHz, 2-12W PL (C24RCB)                     | \$1000      |
| MOT "Micor" 150MHz, 250W, PL. DC (B33RCB)                 | \$2600      |
| MOT "Micor" 162MHz, 100W, C/S. DC (C73RCB)                | \$1200      |
| MOT "Micor" 72MHz, 30W, PL. DC (C42RCB)                   | \$1000/1200 |
| MOT "Micor" 30MHz, 100W, PL. DC (C71RBT)                  | \$1000      |
| MOT "Micor" 25-30MHz, 100W P.A. only (TLB1411)            | New \$300   |
| GE "Mastr II" 150MHz, 250W, w/C r/cvr. (VC96RAS)          | \$1700      |
| Quintron 150MHz, 250W, paging XTRM (QT300A), needs repair | \$700       |
| MOT "Mitrek/M-70" super consolite base                    | Call        |
| MOT "M-70" 150MHz, 45W, 4F, PL. "SP" (L53BBB)             | \$200       |
| GE "Royal Exec." 150/450MHz CL S.S.                       | \$100       |

#### MOBILES

|   |       |
|---|-------|
| MOT "Spectra" 900MHz 12W (D27KMA-B7/B5/B2)              | \$400 |
| MOT "Maxtrax" 12W (D27MWA-B6)                           | \$400 |
| MOT "PP500/PP1000" 800MHz (T35JSA5G05/16) w/o acc'y.    | \$150 |
| As Above wacc'y   | Call  |
| MOT "Master" 800MHz 15W 1-SYS (D35TLA)                  | \$275 |
| MOT "Traxar" 800MHz 10W 1-SYS (D25TA)                   | \$225 |
| MOT "Mitrek" 450MHz 100W, PL/DPL (T74JJA)               | \$400 |
| MOT "Syntor-X" 450/150MHz, 100W, 8F w/acc'g             | \$550 |
| Mot "Syntor-X" 150MHz, 100W, 16F, 8F scan w/ear control | \$600 |
| MOT "Mitrek" 40-50MHz, 50W, C/S w/o TXO/Acc'ys          | \$75  |
| As above w/o BTM cover                                  | \$60  |
| GE "MVS" 450MHz 25W, 2F                                 | \$250 |

#### MOBILE ACCESSORIES

|   |          |
|---|----------|
| MOT "Syntor-X9000" Control Hd. (HCN1032) TRNKD (early)  | \$35     |
| MOT "Syntor-X9000" Control Hd. (HCN1063) 32F conv   | \$50     |
| MOT "Syntor-X9000" Control Hd. (HCN1065) TRND (late)  | \$50     |
| MOT "Syntor-X9000" Control Hd. (HCN1073) 32F Conv   | \$50     |
| MOT "Mertrac" 99F control hd (HCN1052)  | \$50     |
| "SSM" units: TLN 1571/3042, HLN 1198/1225/1241/1300   | 1/3 NSO  |
| MOT "Syntor" 1/4F control Hd. (HCN1004/5)   | \$35/40  |
| MOT "Spectra" MIC (HNM1061)   | \$35     |
| As above noise cancelling (TNN6123)   | New \$35 |
| MOT SYS 90" housing, ivory (TNN6123)  | New \$3  |
| MOT C/COM 12W ampl. spkr w/power cord (NSH 6027)  | \$25     |
| MOT "Maxar-50" hang up box (TRN4655)  | New \$3  |
| MOT "Micor" "Mitrek" "M-70" top/bottom covers   | Call     |
| MOT mobile cables "Syntor-X" "Micor/Syntor" "M-70" Mitrek   | Call     |
| MOT "Pac II" IMTS Accessories   | Call     |
| MOT "Siren" 50W w/PA (N1300) 10 spkr  | Call     |
| MOT "PAC/IT" 150/450MHz rptr, w/o cable   | \$50     |
| MOT nameplate "Syntor-X" "Syntor X2/X3" "Syntor" "M10R" "M-70" "M-35" "Motrac" MX Series, MT500 Series, HT2200 Series, etc. | \$300    |
| GE "Delta" 5W MVB spkr (19C8505G7)  | \$2.5    |
| As above, Qty. 6 or more  | Call     |

#### PORTABLE RADIOS

|   |      |
|---|------|
| MOT "MTX900" 900MHz, 2W trkd/conv w/charger         | Call |
| MOT "MTX800" series 800MHz, 2W trkd/conv, w/charger | Call |
| MOT "HT600/P200" 150/450MHz                         | Call |

#### UNIT PRICE

#### UNIT PRICE

#### UNIT PRICE

|   |           |
|---|-----------|
| MOT "P100" 403-430MHz, 495-500MHz, 4W 2/6F w/acc'y. | New \$300 |
| MOT "P100" 162-174MHz 5W, 2F w/acc'y.               | New \$270 |
| MOT "MX340S" 150MHz 6W, 4F, PL w/o prntr/batt.      | \$150     |
| MOT "MX360" 150MHz 6F, 8F, PL                       | \$100     |
| MOT "MT500" 450MHz 6F, 8F, PL/DPL                   | \$150     |
| MOT "EXPO" 450MHz, 1W, CSD-PL/DPL                   | \$100     |
| MOT "MT500" 136-150MHz, 162-174MHz, 2W, 1F, C/S     | \$50      |
| MOT "HT220" 450MHz 4W 1F, PL remote only            | \$30      |
| As above w/pspk/rmic                                | \$40      |
| MOT "HT220" c/comm 4W, 4F, PL                       | \$50      |
| GE "MPI" 150MHz, 2W, 2F, CG                         | \$100     |
| MOT "PT50C" 150MHz, 5W, 8F, C/S w/acc. batt. pack   | \$125     |

#### CTS/PAGING REEDS AND ACTIVE FILTERS

|  |       |
|--|-------|
| MOT "PL" Reed (TLN6824/KLN6210) Sender               | \$15  |
| MOT "PL" Reed (TLN8381) Spender                      | \$15  |
| MOT "PL" Reed (TLN6709/KLN6209) Spender              | \$15  |
| (Copper Type)  |       |
| MOT "PL" Filter (NFM6010) "MX/MT500/HT90"            | \$15  |
| MOT "PL" Filter (NFM6016) "EXPO"                     | \$15  |
| MOT "PL" Code Plug (TRN4224) "MAXAR/MITREK/SYNTOR"   | \$12  |
| MOT DPL Code Plug (TRN6005) "MAXAR/MICRO/SYNTOR"     | \$12  |
| As above, "PL" and "DPL" Code Plug Blanks w/instruc. | \$6/9 |
| MOT DPL Filter (TLN8922) "MX"                        | \$15  |
| MOT DPL Filter (TLN5762) "MT500"                     | \$15  |
| GE CG Red Network (19B205260G)                       | \$25  |
| GE CG "VERSATONE" (19C320201G)                       | \$12  |
| GE CG Enc/Decoder Reeds (Mid. by Bramco)             | \$15  |
| MOT "QC" or "QCII" filter (TLN8503/7834)             | \$15  |
| NOTE: We Stock MOT GE/PLECTRON/                      |       |
| FEDERAL NON-STD. CODES FOR "PL" "WC1"                |       |
| "QCII" Systems                                       |       |

#### PORTABLE RADIO ACCESSORIES

|  |             |
|--|-------------|
| MOT "GP300/P110" 6-unit rapid charger (HTN748)   | \$250       |
| As above w/bad power supply                      | \$150       |
| MOT "GP300/P110" 1-unit rapid charger (HTN9030)  | \$32        |
| MOT "GP300/P110" spkr/mic (HNM9725) "B" model    | \$35        |
| As above— "C" model                              | \$40        |
| MOT "GP300" carry holster (HNL7949)              | New \$10    |
| MOT "P100/HT90" 1-unit rapid charger (NTN4684)   | \$30/35     |
| MOT "HT600/P200" 1-unit, rapid charger (NTN4633) | \$35        |
| MOT "P50/HT10" 1-unit, rapid charger (HTN9026)   | \$25        |
| MOT "P50/HT10" 16hr, rapid charger (HTN9046)     | \$10        |
| MOT "MX/STX" 1-unit rapid charger (NLM8855)      | \$70        |
| MOT "MT500" 1-unit, rapid Omrn charger (NLM4569) | \$65        |
| MOT "Handle Comm" 1-unit, 16hr charger (NLM8005) | \$25        |
| MOT "MX/STX" 6-unit, rapid charger (NLM8898)     | \$175       |
| MOT "Saber/HT600/Expo" 6-unit, rapid charger     | Call        |
| MOT "P100/HT50" 6-unit, rapid charger            | \$175       |
| MOT "P100/HT50" compact charger (NTN4881)        | New \$10    |
| MOT "P100/HT50" 450MHz antenna (NAE5483)         | New \$3.50  |
| As above   | 12 for \$36 |
| MOT "HT600/P200" spkr/mic (NMM6127/53/56)        | \$40        |
| MOT MacDonald type (SIM to P50) hdset w/o vol    | New \$20    |
| MOT "GP300/P110" 16F Escutcheon                  | New \$5     |

#### LOCAL/REMOTE CONSOLE/DESK SETS

|  |                                     |
|--|-------------------------------------|
| MOT "T1617" series 4/6 ch. dc remote   | \$800/1,000                         |
| MOT "T1602" dc remote console w/desk mic   | \$250                               |
| MOT "T1375/7780" dc remote handset   | \$125                               |
| MOT "Series 90" dc remote cons:  | new/Used \$150/125                  |
| (T1901/T1902/1881/1882)  | As above 1881/1902 NEED REPAIR \$40 |
| MOT T1903 "Series 90" local console  | new/used \$100/75                   |
| Misc. DC handsets: SECODE-M-70, SSC-81/FTY234...   | new/used \$100                      |
| IDA24-10, Comm. Prod. RD11-8   | \$75                                |
| MOT "T1383" long remote desk set   | new/used \$100                      |
| MOT "T1926" "Series 90" tone remote console  | \$125                               |
| Misc. tone handsets: Secode-M-80, Comm. Prod. RT32   | \$75                                |
| SSC tone remote adaptor Bo. (B32AY)  | \$60                                |
| Calgary DC remote adaptor Bo. (648B)   | \$45                                |
| GE base mic, New style (19C85086P16)   | New \$45                            |
| Misc. Manual phone patch—MOT-B1203, SYT-I2/240 (New), Data Sig.—RAP400, Trac III (New), SYT850 | \$50                                |
| MOT "RAX4020" overvoltage protector (OEM TH1416)   | New \$20                            |
| GE "Mastr" dc controller, CG, DTMF enc. w/desk mic (539A251)                                   | \$90                                |
| GE "Mastr" local controller, 2F, CG, w/desk mic (659A252)                                      | \$50                                |

#### POWER SUPPLIES

|  |           |
|--|-----------|
| MOT HPM1001/HPN1007/TPN1136, 7A, 12VDC                 | \$75      |
| MOT HPM3196/HPN1008/TPN1154, 10A, 12VDC                | \$95      |
| MOT "Mitrek" console low power A.C. (NPN1002)          | New \$100 |
| GE "Mastr" II base station, 100W, 30A (19D4302726)     | \$175     |
| GE "Phoenix" 10A (19D430175G1)                         | \$60      |
| GE "Pro" base station (4EP39A12)                       | 100       |
| GE "Pro" receiver only (4EP39A12)                      | \$50      |
| Above w/VHF or UHF receiver                            | \$70      |
| FADAGS P/N DCS-12-10S, 10A, 12VDC                      | \$50      |
| GLENAYRE M203, DC-DC converter, 48VDC in, 13-6VDC, 12A | \$50      |
| MOT "Micor", "Syntor-X" console chassis w/o P.S./cover | Offer     |
| ASTRON "RS-12A" 12A, 12VDC                             | \$60      |

#### CAVITY-DUPLEXERS ETC.

|   |           |
|---|-----------|
| WACOM 150MHz Dplkr (WP420-2)                | New \$250 |
| WACOM 150MHz notch filter (WP539-1), 162MHz | \$125     |
| WACOM 133MHz B/P cavity (WP428), 134MHz     | \$125     |
| Sinclair R2B13C dplkr, 143/148MHz           | \$200     |
| Sinclair R217C dplkr, 164/159MHz            | \$200     |
| RJ Comm. RMG 150-116R 150MHz, 12-Multi-C    | \$125     |
| MOT "T1504" 450MHz, B/R dplkr.              | \$325     |

#### UNIT PRICE

|  |       |
|--|-------|
| MOT "PL" Reed (TLN6824/KLN6210) Sender               | \$15  |
| MOT "PL" Reed (TLN8381) Spender                      | \$15  |
| MOT "PL" Reed (TLN6709/KLN6209) Spender              | \$15  |
| (Copper Type)  |       |
| MOT "PL" Filter (NFM6010) "MX/MT500/HT90"            | \$15  |
| MOT "PL" Filter (NFM6016) "EXPO"                     | \$15  |
| MOT "PL" Code Plug (TRN4224) "MAXAR/MITREK/SYNTOR"   | \$12  |
| MOT DPL Code Plug (TRN6005) "MAXAR/MICRO/SYNTOR"     | \$12  |
| As above, "PL" and "DPL" Code Plug Blanks w/instruc. | \$6/9 |
| MOT DPL Filter (TLN8922) "MX"                        | \$15  |
| MOT DPL Filter (TLN5762) "MT500"                     | \$15  |
| GE CG Red Network (19B205260G)                       | \$25  |
| GE CG "VERSATONE" (19C320201G)                       | \$12  |
| GE CG Enc/Decoder Reeds (Mid. by Bramco)             | \$15  |
| MOT "QC" or "QCII" filter (TLN8503/7834)             | \$15  |
| NOTE: We Stock MOT GE/PLECTRON/                      |       |
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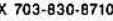
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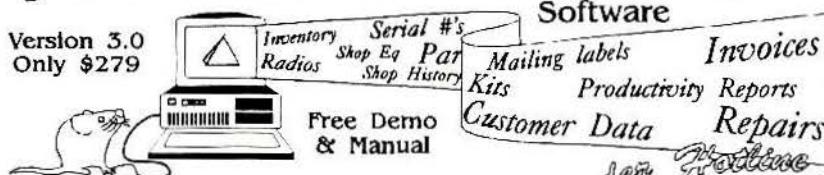
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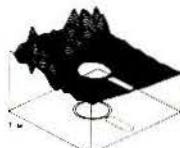
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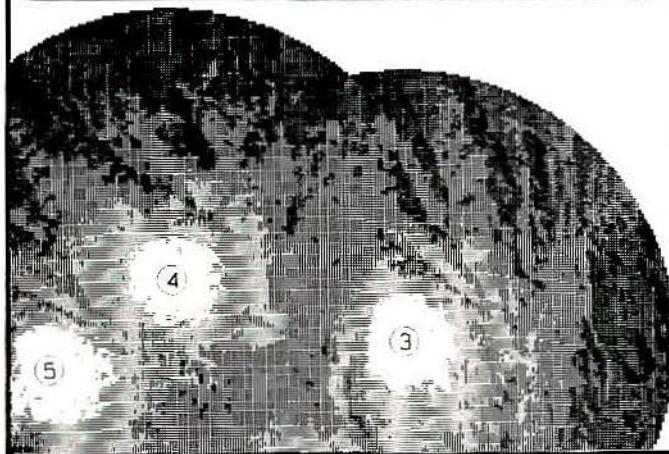
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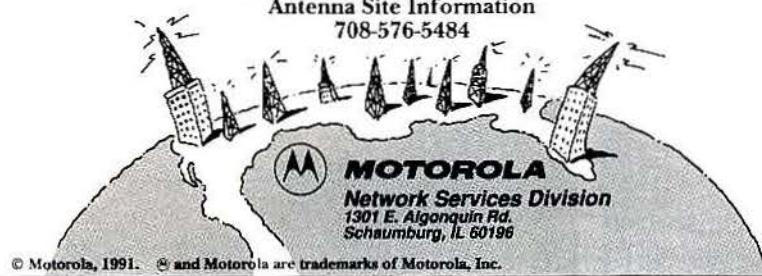
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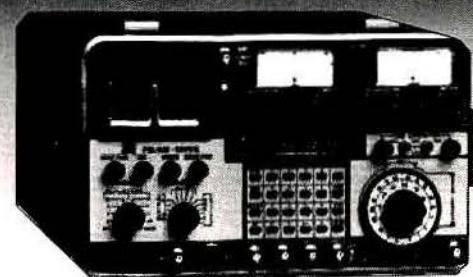
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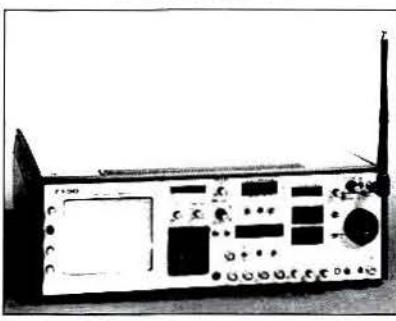
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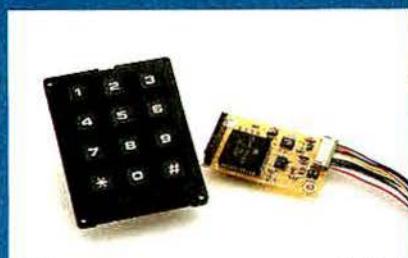
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**A**

*Index/hot line*

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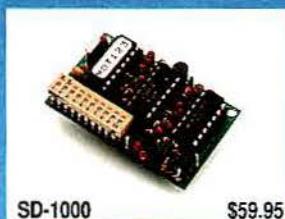
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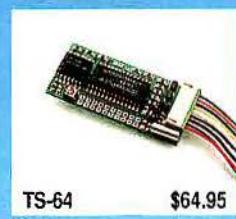
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